PRELIMINARY

OPERATING AND SERVICE MANUAL

MODEL 8057A

PRECISION NOISE GENERATOR

SERIAL PREFIXED: G910

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Table 1–1. Specifications

Period of Noise Pattern: Approx. 2 sec. (for external clock 1,048,575 x clock period).

Harmonic Spacing, Δf: Approx. 0.5 Hz (for external clock, $\Delta f = \frac{\text{clock frequency}}{1{,}048{,}575}$).

WHITE NOISE

Power Spectrum: Rectangular, low pass. Nominal upper limit frequency (3 dB point) is 26 kHz (or 1/20th of external clock frequency). Effective bandwidth: 27 kHz. Spectrum is flat within ± 0.3 dB up to 15 kHz, and more than 25 dB down at 52 kHz.

Power Density: 362×10^{-6} V^2/Hz.

Crest Factor: 3.5

Probability Density Function: Near Gaussian.

PINK NOISE

Power Spectrum: 3 dB/octave decreasing from 3 Hz to 20 kHz. Deviation from ideal decrease: ± 0.5 dB up to 15 kHz + 0 dB, - 1.5 dB at 20 kHz.

Intersection of White and Pink Noise Power Density Spectrum: Approx. 2.6 kHz

Amplitude: (open circuit) 3.126 V rms ± 2% or 129.9 dB ± 0.2 dB above 1 μV.

Amplitude Attenuator: 0.1, 1, and 10 dB steps from 129.9 to 20 dB above 1 μV. Overall attenuator accuracy ± 0.5 dB.

Output Impedance: 50 Ω or 600 Ω ± 3%.

DC Offset: < ± 50 mV from 32°F to 122°F (0°C to 50°C).

BINARY OUTPUT

Output Signal: Pseudo-random binary sequence (NRZ). Clock rate: 520 kHz (or external clock). Sequence length (clock periods per sequence): 1,048,575.

Amplitude: (open circuit) 10 V ± 10%.

Output Impedance: Approx. 600 Ω.

Rise & Fall Time: < 70 nsec.

TRIGGER OUTPUT

Pos. trigger pulse indicates period of the noise pattern.

Trigger Pulse Amplitude: Approx. 10 V.

Output Impedance: Approx. 1 kΩ.

Trigger Pulse Width: 2 μsec. (or equal to clock period of external clock frequency).

EXTERNAL CLOCK INPUT

(Only for white noise output).
Pos. clock pulses (min. + 2 V; max. + 20 V amplitude) (sine wave at least 4 V peak to peak)

Max. Clock Rate: 1 MHz

Min. Pulse Width: 30 ns.

Input Impedance: Approx. 1 kΩ.

GATE INPUT: - 1V to + 2.8 V or connected to ground: disables Noise Output. (Gate Input connected to ground: Output current approx. 2.5 mA).

FLOATING GROUND: All Input/Output Terminals are isolated from chassis. A maximum of 500 V may be connected between floating ground and chassis.

OUTPUT TO EXTERNAL FILTER

Pin 3	+ 15 V, output current 100 mA
Pin 1	– 15 V, output current 100 mA
Pin 2	Floating ground
Pin 4	Noise output
Pin 5	Input from external filter.

GENERAL

Environment: Ambient temperatures from 0°C to 50°C and relative humidity to 95% at 40°C.

Power: 115 V or 230 V + 10% - 15%, 50 Hz to 400 Hz, 14 VA.

Dimensions: Standard HP 1/2 module; 6 in. high, 7-3/4 in. wide, 11 in. deep (155 x 190 x 279 mm).

Weight: Net, 8 lbs (3.5 kg). Shipping 10 lbs (4.5 kg).

SECTION I

INTRODUCTION

1–1 DESCRIPTION

1-2 The Hewlett-Packard Precision Noise Source 8057A is an audio frequency noise generator producing pseudo-random noise figures at binary and Gaussian distribution outputs. These signals are repeated noise patterns of known content and duration. Both white and pink noise with an equal rms value can be selected by push buttons. By producing a defined rms value, the high stability of the output level allows a directly calibrated attenuator with 0.1 dB resolution. This makes the 8057A a highly accurate noise source.

1–3 The basis of the 8057A is a clock-controlled binary waveform generator arranged so that the transitions between output levels can occur only on "beats" of the internal clock. Alternately the waveform generator can be timed by an external clock of frequency up to 1 MHz. Therefore, the bandwidth can be varied externally. The binary waveform generator is a shift register which operates under the control of a feedback mechanism. With feedback the shift register generates a binary sequence which alternates between levels in an apparently random manner. The output from the shift register is in fact a known sequence - of binary ones and zeros - which repeats after a fixed number of clock periods. The length of a pseudo-random binary sequence of this type is stated in terms of a number of clock periods and is equal to $N = 2^n - 1$, where n is the number of shift register stages used to generate the sequence. In the 8057A n is fixed at 20, thus giving a sequence length of 1,048,575 clock periods.

1–4 The shift register and a digital-to-analog converter together form a low-pass digital filter. This filtering mechanism converts the family of two-level outputs from the shift register into a multi-level signal having a Gaussian probability density function and a flat power spectrum. Crest factors up to 3.5 give a remarkably close fit to the Gaussian distribution. The unique feature of the digital filter produces a bandwidth which is directly proportional to the clock frequency. Complete specifications are given in Table 1–1.

1–5 MANUAL IDENTIFICATION

1–6 Hewlett-Packard uses a two-section eigh-digit serial number (000–00000). This serial number may also be preceded by a letter. If the first three digits of the serial number, found on the rear panel of the instrument, do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 8057A described in this manual. To obtain correct manual information for any instrument, contact the nearest Hewlett-Packard Sales/Service Office; always specify the model number and serial number.

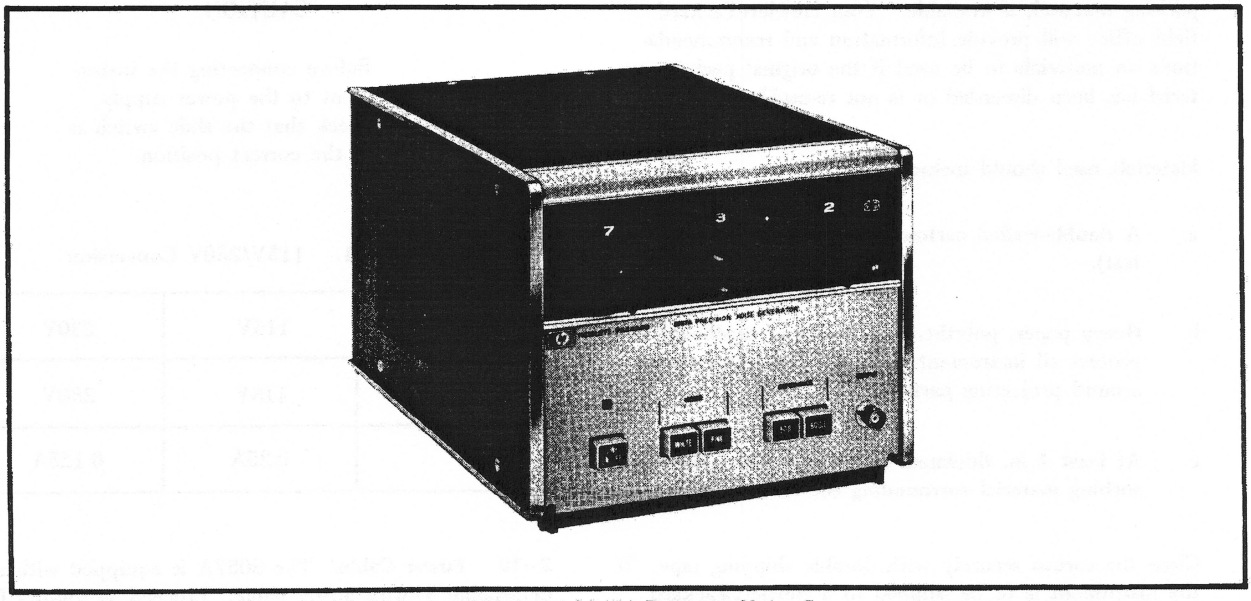


Figure 1–1. Model 8057A Precision Noise Generator

SECTION II

INSTALLATION

2–1 INTRODUCTION

2–2 This section contains information on unpacking, inspection, storage, shipment, and installation.

2–3 UNPACKING AND INSPECTION

2–4 If the shipping carton is damaged, ask that the carrier's agent be present when the instrument is being unpacked. Inspect the instrument for damage (scratches, dents, broken knobs, etc.). If the instrument is damaged or fails to meet specifications (Performance Check, Section V), notify the carrier and the nearest Hewlett-Packard field office immediately (field offices are listed at the back of this manual). Retain the shipping carton and the padding material for the carrier's inspection. The field office will arrange for the repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2–5 STORAGE AND SHIPMENT

2–6 Packaging. Use the original shipping carton and packing material, if available. Your Hewlett-Packard field office will provide information and recommendations on materials to be used if the original packing material has been discarded or is not re-usable.

Materials used should include:

a. A double-walled carton (350 lb/sq. in. bursting test).

b. Heavy paper, polythene or sheets of cardboard to protect all instrument surfaces. Use extra material around projecting parts.

c. At least 4 in. thickness of tightly-packed shock-absorbing material surrounding the instrument.

Close the carton securely with durable shipping tape. If the instrument is to be shipped to a Hewlett-Packard field office, attach a tag showing owner and address, model number, serial number, trouble symptoms and/or repairs required.

2–7. Environment. Conditions during storage and shipment should be limited as follows:

a. Maximum altitude 20,000 feet.

b. Minimum temperature – 40°F (– 40°C)

c. Maximum temperature + 167°F (+ 75°C).

2–8 POWER CONNECTION

2–9 Line Voltage. The 8057A will operate from either 115V or 230V (± 10%) power lines. A slide switch on the rear panel permits rapid selection of the appropriate line transformer tappings. Insert a screwdriver into the switch slot and slide the switch to expose the appropriate number (115 or 230). For fuse ratings see Table 2–1.

CAUTION

Before connecting the instrument to the power supply, check that the slide switch is in the correct position.

Table 2–1. 115V/230V Conversion

Line voltage	115V	230V
Slide switch	115V	230V
Fuse	0.25A	0.125A

2–10 Power Cable. The 8057A is equipped with a detachable 3–wire power cable. Proceed as follows for installation:

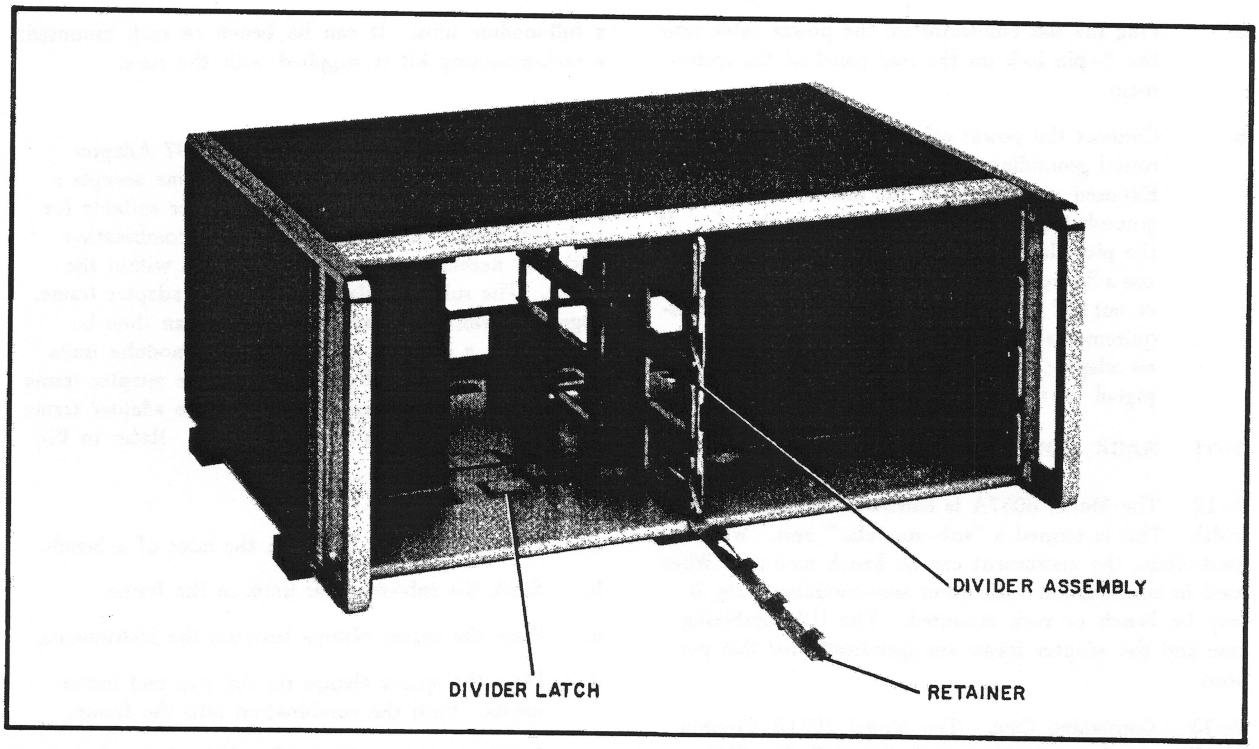


Figure 2–1. The Combining Case

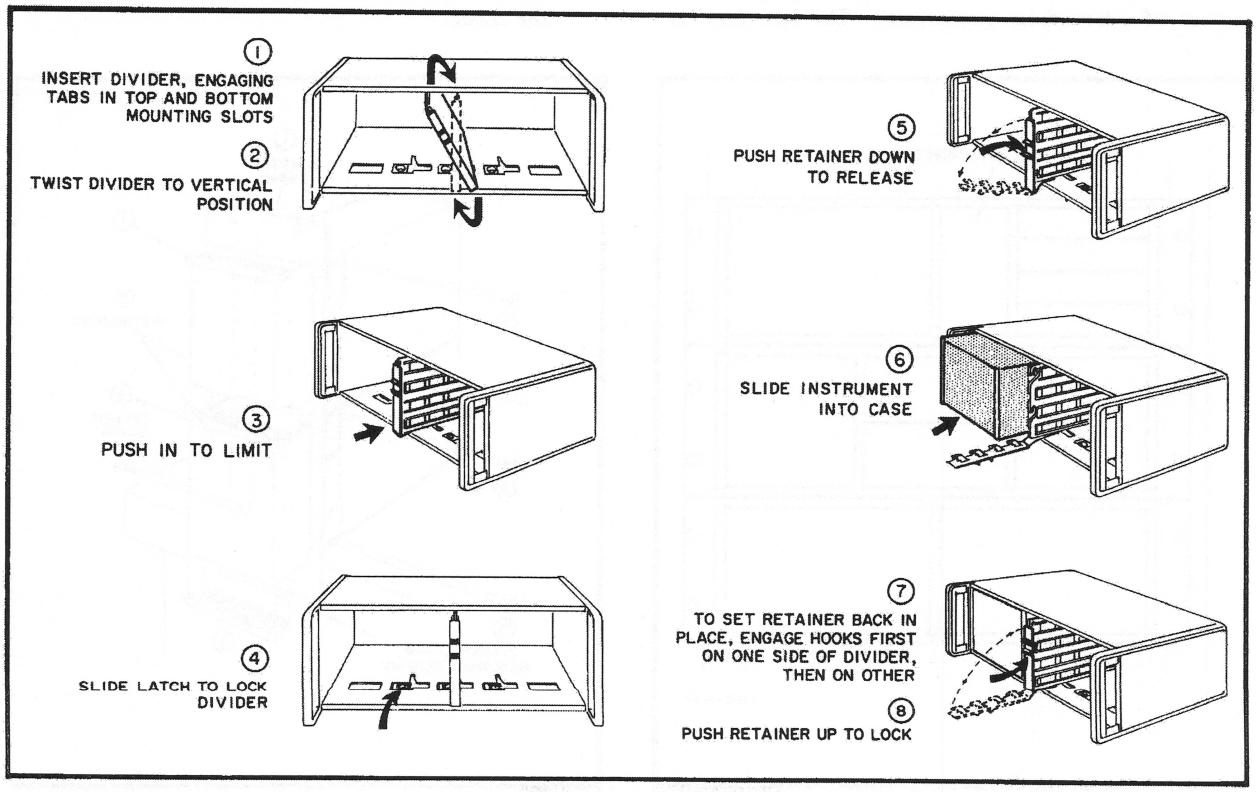


Figure 2–2. Steps to Place Instrument in Combining Case

a. Plug the flat connector on the power cable into the 3–pin jack on the rear panel of the instrument.

b. Connect the power cable plug (2–blade with round grounding pin) to a 3–wire power outlet. Exposed metal parts of the instrument are grounded through the round pin on the plug. If the plug does not fit your power outlet, either use a 3-blade to 2-blade adapter (HP 1251–0048) or cut off the plug and fit one to suit your requirements. If the instrument is powered, via an adapter, from a 2–contact outlet, the green pigtail on the adapter should be grounded.

2–11 RACK MOUNTING

2–12 The Model 8057A is narrower than full–rack width. This is termed a "sub–modular" unit. When used alone, the instrument can be bench mounted. When used in combination with other sub–modular units, it may be bench or rack mounted. The HP combining case and the adapter frame are specifically for this purpose.

2–13 Combining Case. The Model 1051A Combining Case is shown in Figures 2–1 and 2–2. This case is a full-rack width unit which accepts varying combinations of sub-modular instruments. The case itself is a full-module unit. It can be bench or rack mounted; a rack-mounting kit is supplied with the case.

2–14 Adapter Frame. The 5060–0797 Adapter Frame is shown in Figure 2–3. The frame accepts a variety of sub–modular units in a manner suitable for rack mounting. Sub–modular units, in combination with any necessary spacers are assembled within the frame. The sub–modular units and the adapter frame, together forming a complete assembly, can then be mounted in a standard rack. The sub–modular units cannot be removed individually when the adapter frame is used. Instructions for assembly of the adapter frame and sub–modular units are given below. Refer to Figure 2–4.

a. Place the adapter frame on the edge of a bench.

b. Stack the sub–modular units in the frame.

c. Place the spacer clamps between the instruments.

d. Place the spacer clamps on the two end instruments. Push the combination into the frame.

e. Insert screws on either side of the frame and tighten until the sub–modular units are tight in the frame.

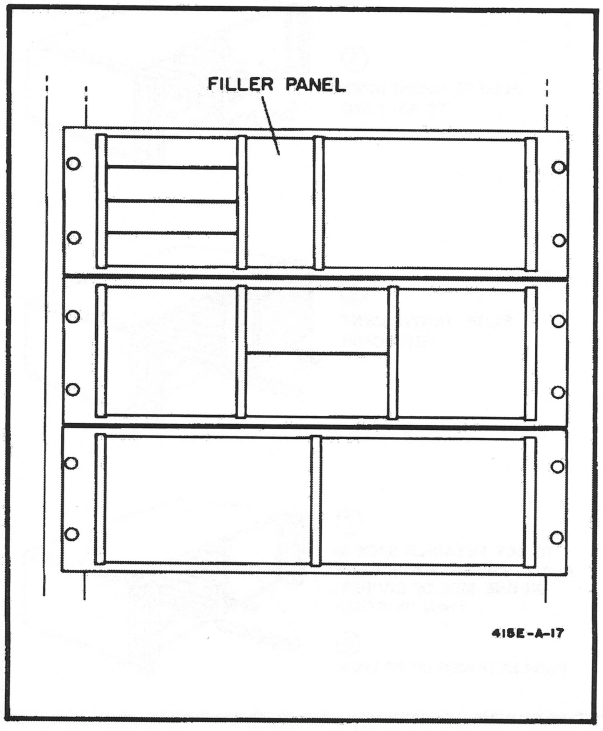


Figure 2–3. Adapter Frame Instrument Combinations

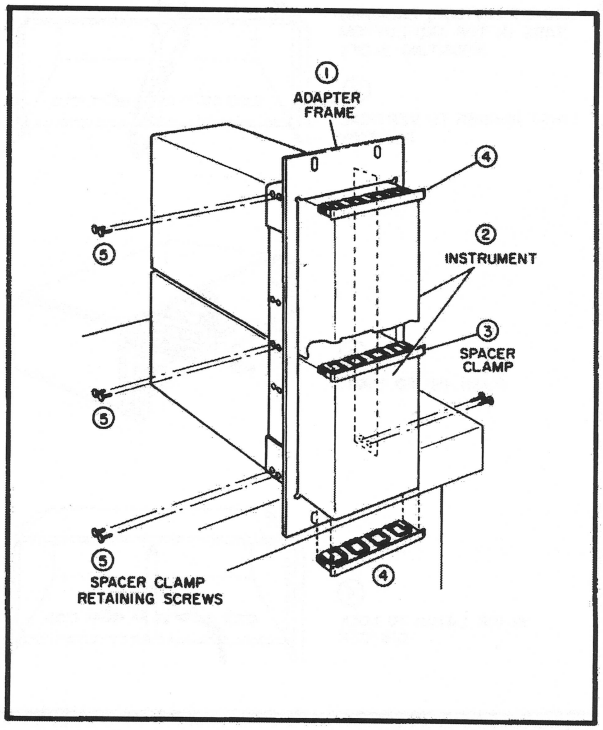


Figure 2–4. Two Half Modules in Rack Adapter

SECTION III

OPERATING INSTRUCTIONS

3–1 DESCRIPTION

3–2 This section provides information for operating the Precision Noise Generator Model 8057A. It also contains a turn–on procedure followed by a front and rear–panel description.

3–3 Either white or pink noise, with equal rms values, can be selected by depressing the respective front–panel button. With the precision step attenuator set to 129.9 dB, there is a maximum output voltage of 3,126V rms present at the front–panel connector labeled "OUTPUT", provided the rear–panel "OUTPUT CONNECTOR" switch is set to "NORMAL". The attenuator provides control of the output in 0.1, 1, and 10 dB steps from 129.9 dB down to 20 dB above 1 μV rms. The required output impedance of either 50 or 600 Ω can be selected by operating the respective push button.

3–4 The pseudo-random binary sequence with a fixed amplitude of + 10 V is available from the rear-panel connector labeled "BINARY OUTPUT". A trigger pulse, indicating the period of the noise sequence, is available from the "TRIGGER OUTPUT" connector. This trigger is not present when the slide switch on assembly A2 is set to "T".

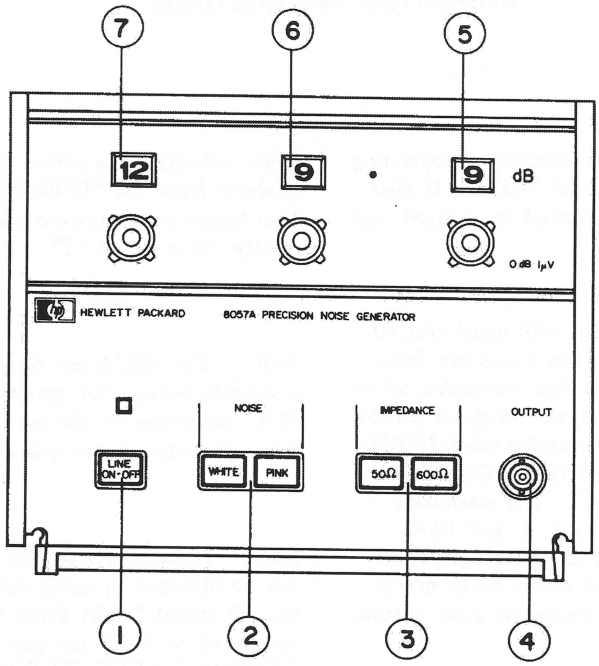
3–5 The 8057A can be gated externally by applying a suitable voltage (see specifications) to the "GATE INPUT" connector on the rear panel. On enabling the noise generator, a new pulse sequence commences.

3–6 Noise power spectra other than white or pink can be obtained by using suitable external filters such as the HP Model 8055A Filter Set. When the filters are connected to the 5-pin rear-panel jack labeled "CONNECTION TO EXT. FILTER" and the "OUTPUT CONNECTOR" switch is set to "CONNECTION TO EXT. FILTER", the desired noise is present on the "OUTPUT" connector.

TURN–ON PROCEDURE

Perform the following steps sequentially when switching on Model 8057A.

1. Check line voltage selector on rear panel. Connect Supply.
2. Set CLOCK switch on rear panel to INT (or EXT if an external clock is to be used to time the 8057A: For specification of external clock refer to Table 1–1).
3. Set OUTPUT CONNECTION switch on rear panel to NORMAL.
4. Operate LINE ON-OFF button. Neon indicator above push button should light.
5. Depress desired noise selection button: WHITE or PINK.
6. Select desired output impedance, depressing the 50 or 600 Ω button respectively.
7. With attenuator switches set to 129.9 dB, noise output amplitude is 3.126 V rms ± 2%.



FRONT PANEL CONTROLS

1. LINE ON – OFF control. Latching push button. When operated, the neon indicator lamp (above) glows.

2. NOISE SELECTION control. Push buttons, push - pull coupled for selection of either WHITE or PINK noise.

3. IMPEDANCE SELECTION control. Push buttons, push - pull coupled for selection of either 50 or 600 Ω output impedance.

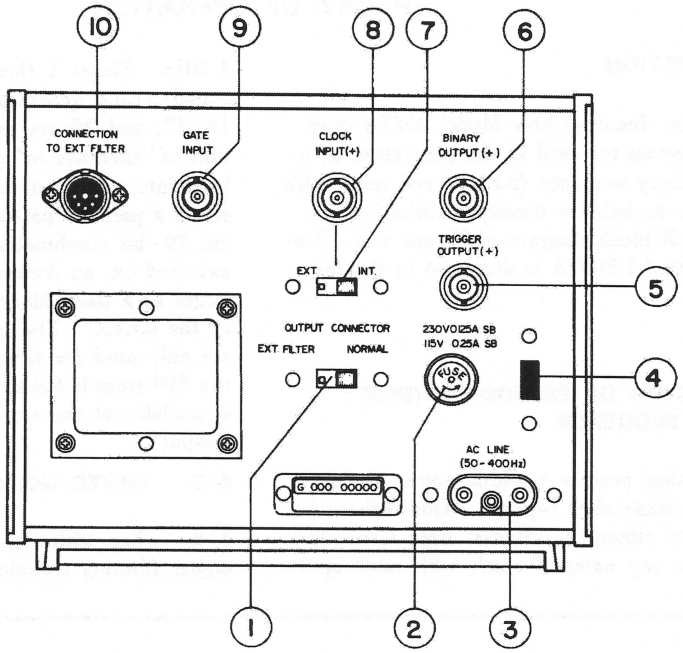
4. NOISE OUTPUT connector. Selected noise (WHITE OR PINK) is available at this BNC connector.

5. 0.1 dB ATTENUATION switch. Attenuates output noise in 0.1 dB steps.

6. 1 dB ATTENUATOR switch. Attenuates output noise in 1 dB steps.

7. 10 dB ATTENUATOR switch. Attenuates output noise in 10 dB steps.

Figure 3–1. Front Panel Controls



REAR PANEL CONTROLS

1. OUTPUT CONNECTION switch. Slide switch connects noise output signal to the front-panel OUTPUT BNC either directly or via Model 8055A or any other external filter.

2. FUSE HOLDER

3. POWER receptacle. The Model 8057A is powered by 230 or 115 V AC, 50 to 400 Hz ac supply.

4. POWER SELECTION switch. Slide switch to select desired supply voltage.

5. TRIGGER OUTPUT connector. Positive going trigger pulse (≈ 10 V), indicating the periode of noise pattern.

6. BINARY OUTPUT connector. Pseudo-random binary sequence of 1,048,575 bits. Amplitude: 10 V.

7. CLOCK SELECTION switch. Slide switch selects internal or external clock.

8. CLOCK INPUT connector for external clock signal. NOTE: To be used only for WHITE noise output.

9. GATE INPUT connector. Any external signal level between – 1 V and + 2.8 V disables noise output.

10. CONNECTION to 8055A or any other external filter.

Figure 3–2. Rear Panel Controls

SECTION IV

THEORY OF OPERATION

4–1 INTRODUCTION

4–2 This section describes how Model 8057A operates. The main circuits involved in the generation of a pseudo–random binary sequence (p.r.b.s.) and noise with Gaussian amplitude probability density distribution are shown in the overall block diagram of Figure 4–1. General operation of Model 8057A is discussed in the following paragraphs.

4–3 GENERATION OF PSEUDO–RANDOM BINARY SEQUENCE

4–4 In generating pseudo–random noise, Model 8057A uses a 32–stage shift register. This register is clock controlled by either the internal Rate Generator (520 kHz fixed) or any external clock with rates up to 1 MHz. Stages 1 through 20 of the register form the actual p.r.b.s. generator. The binary state of stages 1, 16, 17, and 20 are modulo–two added in a combination of "exclusive or" gates. The resulting output is fed back into stage 1 of the register. This closed loop generates a periodic pattern of $2^{20} - 1 = 1{,}048{,}575$ different 20 - bit combinations. When the instrument is first switched on, an Automatic Start circuit sets all register stages to a fixed binary combination to ensure the start of the p.r.b.s.. The last 12 stages of the shift register are only used for white noise generation. The output of the 31st stage is fed to the binary amplifier. The p.r.b.s. is available at the rear - panel connector labeled "Binary Output".

4–5 WHITE NOISE GENERATION

4–6 For white noise generation Model 8057A uses digital filtering techniques.

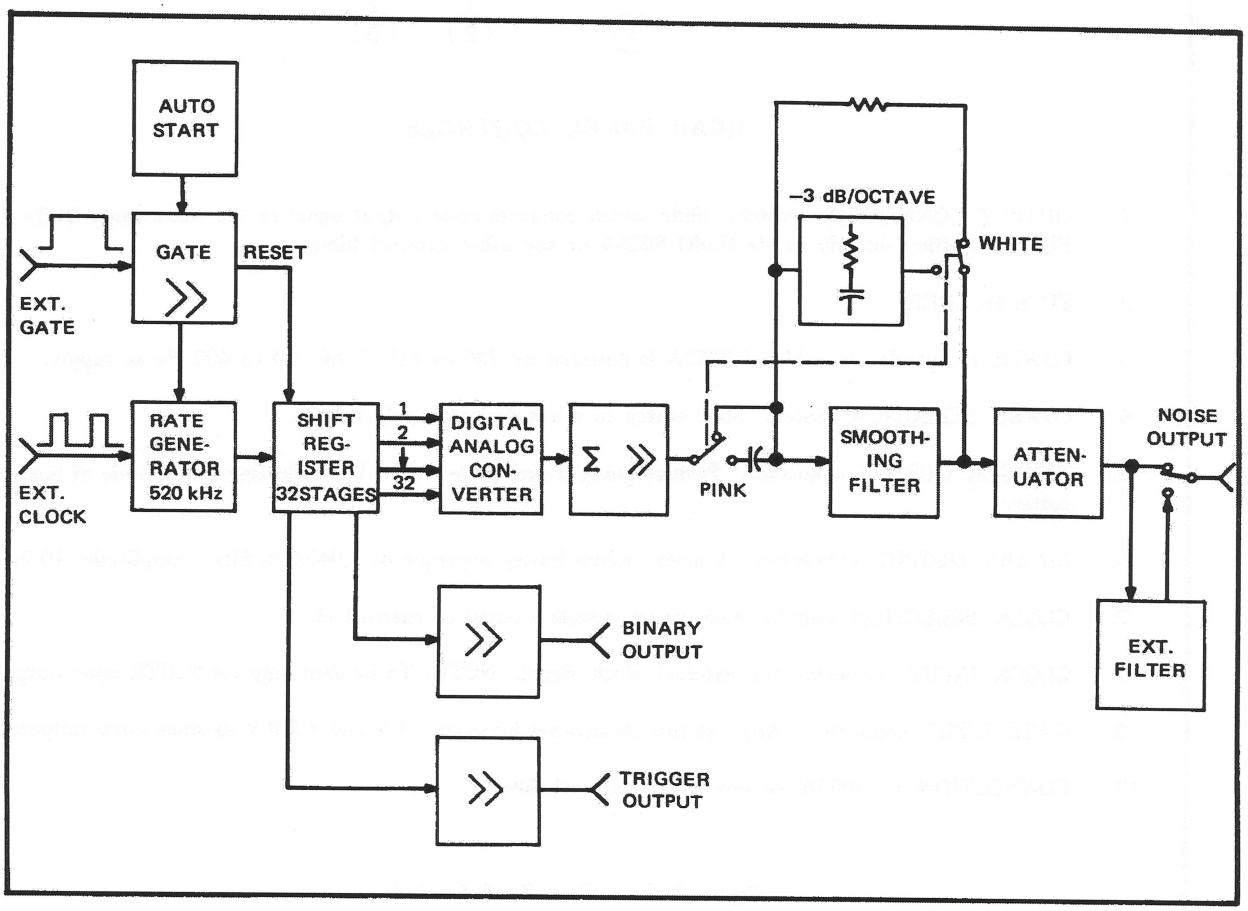


Figure 4–1. 8057A Block Diagram

4–7 Digital to Analog (D/A) Converter

4–8 In the D/A Converter the outputs of the shift register stages are connected via weighting resistors to a summing point. Since the signal at this point represents the sum of 32 almost independent p.r.b. sequences, its probability density distribution approximates the Gaussian curve, according to the central limit theorem. The power spectrum of this signal is determined by the weighting resistor network. To generate an ideal rectangular power spectrum, the conductances of the weighting resistors should follow a $\frac{\sin x}{x}$ curve from one end of the shift register to the other. Due to the finit shift register length of 32 stages, this approximation is limited to a certain interval, causing a deviation from the ideal rectangular spectrum shape. Therefore, the approximation interval is properly selected and a correction to the $\frac{\sin x}{x}$ curve is made, to give a good approximation to the ideal rectangular spectrum.

4–9 Since the 8057A generates a periodic noise pattern, the power spectrum consists of discret spectral lines. The power per spectral line is independent of clock frequency. Clock frequency f_c, however, affects the spacing between the harmonic components Δf and also the upper limit frequency f_o (–3 dB point) of the power spectrum:

$$\Delta f = \frac{f_c}{N} \quad \text{where N is the sequence length}$$

$$fo = \frac{1}{20} \cdot f_c$$

4–10 Summing Amplifier and Filter

4–11 The output signal of the D/A Converter is fed to the summing amplifier followed by an active smoothing filter, which limits the bandwidth to 110 kHz. In white noise operation the output of the summing amplifier is dc–coupled via the smoothing filter to the output.

4–12 PINK NOISE GENERATION

4–13 Pink Noise is generated by analog filtering of white noise, switching an RC–network in the feedback loop of the Smoothing Filter Amplifier, to perform a 3 dB per octave decrease of the power spectrum. In this case, summing amplifier and filter amplifier are ac–coupled, limiting the low frequency end of the spectrum to 1 Hz.

Both White and Pink noise are applied to the attenuator. Via the impedance selection switch (50 Ω or 600 Ω) the noise signal reaches the "OUTPUT" connector on the front panel.

4–14 EXTERNAL FILTER OPERATION

4–15 With the "OUTPUT CONNECTOR" switch on the rear panel, the output signal may be connected over "CONNECTION TO EXTERNAL FILTER" on the rear panel to any external filter. Then the "OUTPUT" connector is connected so that the filtered noise is available at the front panel of the 8057A. For special use of the HP Model 8055A (Filter Set), the supply voltages + 15 V and – 15 V are also available at the audio connector.

4–16 GATED OPERATION

4–17 Gating signals, applied to the rear-panel connector labeled "Gate Input", will gate the instrument "ON", to produce bursts of noise. After GATING the Rate Generator is stopped and the shift register is reset to a fixed combination. Therefore, the noise bursts contain always the same noise pattern. In the gated operation, the trigger pulse appears with the first clock pulse after gating. (See Figure 4–2)

4–18 Trigger Output

4–19 To indicate the period of the noise pattern, a positive going trigger pulse is derived from the sequence generator by a diode gate. It is available at the rear-panel connector, labeled "Trigger Output".

4–20 DETAILED CIRCUIT DESCRIPTION

4–21 Clock Generator

4–22 Clock pulses are generated at a rate frequency of 520 kHz in internal operation. When, however, the rear-panel switch S1 is set to "EXT", the generator can be triggered with any frequency up to 1 MHz. Transistors Q39 through Q41 make up the generator.

4–23 INTERNAL OPERATION

4–24 Initially transistors Q39 and Q41 are conducting. Transistor Q40 serves as a constant current source. It first charges C3 with negative voltage until the emitter of Q39 is negative enough to open this transistor. Thus the base of Q41 becomes less positive and this transistor starts conducting too. This way the base of Q39 becomes more positive (positive feedback) and both transistors get into saturation. Now C3 is charged through Q39 in positive direction. When the base voltage on Q39 reaches a value for which the current flowing through R109 and R108 becomes equal, base currents of

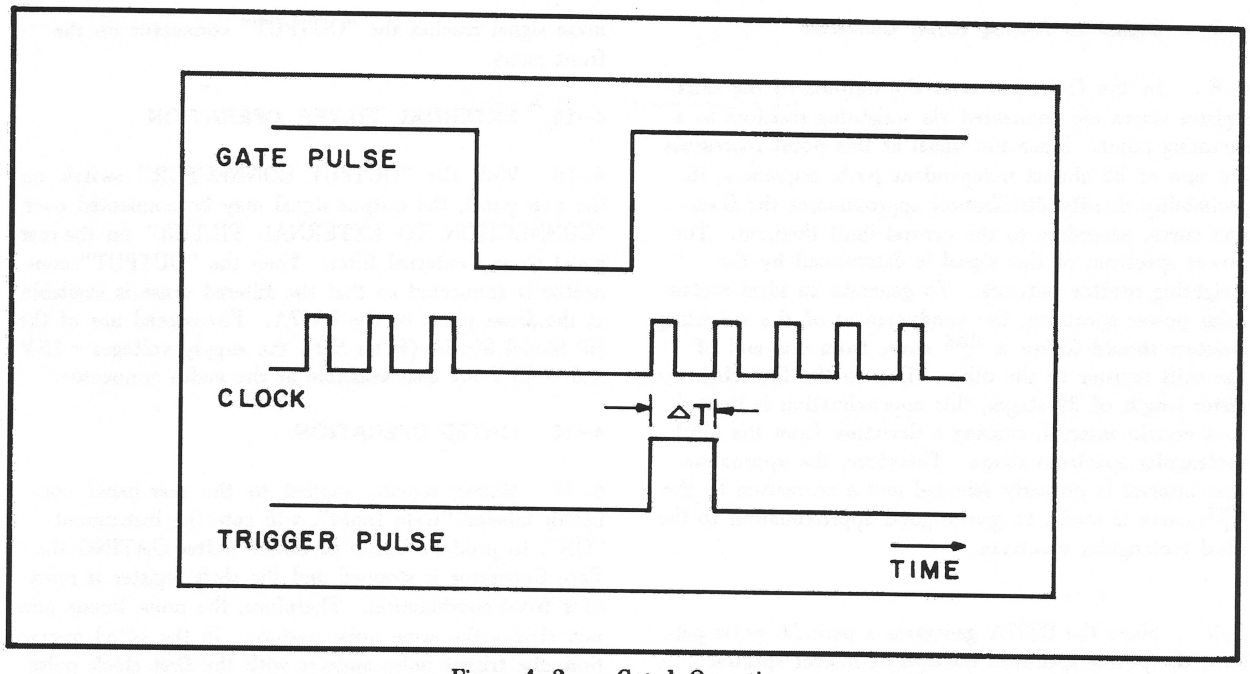


Figure 4–2. Gated Operation

Q39 and Q41 are reduced, terminating the saturation of both transistors. Then the base of Q41 becomes more positive, reducing the forward biasing of Q39, which makes the base of Q41 even more positive. This feedback turns off Q39 and Q41, and C3 is charged again in negative direction as described above. Via CR32 the generated pulses are fed to the pulse shaping network consisting of Q44 through Q46.

4–25 EXTERNAL OPERATION

4–26 For this mode of operation the rear-panel switch is set to "EXT". Thus the clock generator is stopped by the negative potential from voltage divider R112, CR30, and R113 applied to the base of Q39; the voltage at capacitor C3 is clamped by diodes CR28 and CR29, so that Q39 certainly cannot conduct. When a positive trigger signal is applied to J4, Schmitt Trigger Q42/Q43 sends a short positive pulse - shaped by L1 and R117 - via CR31 to the base of Q39. This initiates one generator cycle as described above. In this mode, R107 is in parallel to R106 so that the negative charging current for C3 is increased. This way the clock generator allows external clock frequencies of up to 1 MHz.

4–27 GATED OPERATION

4–28 When the "Gate Input" is high, i.e. open or + 4.5 to + 10 volts, Q36 is conducting, keeping Q37 turned off. This state becomes reversed when the "Gate Input" is low (grounded or – 1 to + 2.8 volts). With Q37 conducting, also Q38 is turned on, consuming all current from Q40. Hence, the clock generator is stopped. At the same time, Q37 sends a Reset pulse to the shift register, presetting all 32 flip-flops for the next start. Thus, the shift register is always started with the same 32-bit binary word.

4–29 AUTOMATIC START

4–30 When Model 8057A is turned on - while the "Gate Input" is high - the Automatic Start makes sure that the shift register does not hold 32 binary zeros, which would disable the noise generation. As soon as the proper voltage is present at the base of Q34, C2 is charged via Q34 and R94. When the voltage across C2 has reached the threshold voltage of uni-junction transistor Q35, C2 gets discharged via Q35, R95, CR23, and R98. This reduces the emitter current of Q36, and turns on Q37, which sends a short Reset pulse to the shift register.

4–31 Shift Register

4–32 The Shift Register consists of 32 edge-triggered flip-flops; each micro-circuit chip contains two of them. Flip-flops 1 through 20 are used for the generation of the pseudo-random binary sequence. This sequence is generated in the following way: The out-

puts of flip-flops 1 and 16 are sensed by exclusive– or gate MC18; a second "exclusive or" gate – MC19 – is linked to the outputs of flip-flops 17 and 20. The inverted and non-inverted outputs of MC18 and MC19 are then fed to a third "exclusive or" gate (P/O MC17). Finally the output of this gate (pin 6) gets via A2S1 (set to "Normal") back to the D-input of the first shift register flip-flop (pin 2). Now the loop is closed and the 20 flip-flops generate a periodic pattern of 1,048,575 different 20-bit combinations.

4–33 Before the first clock pulse starts the shift register, a Reset pulse from Q37 is applied to the reset– or clear input of all 32 flip-flops, so that the shift register is set to the following binary word: (reading from flip-flop 1 through 32) 11111 11000 11001 11100 00000 11100 01. Then the 20-bit word, generated by the first 20 flip-flops, is shifted on via flip-flops 21 through 32. If flip-flop 31 is low (+ 10.2 V), Q21 conducts, keeping Q22 turned off When flip flop 31 is in the high state (+ 13.6 V), the voltage at R60 is clamped by the emitter base diode of Q22. This way Q21 is turned off, while Q22 is conducting the "high" state to the "Binary Output" connector J3 (rear panel) Output amplitude of the binary word is + 10 volts.

4–34 The period of the pseudo-random noise pattern is indicated by a + 10 volts trigger supplied to the rear panel "Trigger Output" connector J2. Trigger generation is accomplished in the following way: Diodes CR1 through CR20 are connected to the Q– or $\overline{Q}$– outputs of the first twenty shift register flip-flops. These diodes make up a 20–input AND gate. When they all simultaneously sense high state at the outputs of the respective flip-flops, the bias of Q19 becomes positive (via A2-CR19, A2CR18, and A2R90) and this transistor conducts. Thus Q20, which normally is conducting, gets turned off. This situation occurs, when the first clock pulse has shifted the previously reset register. About two microseconds later (clock rate = 520 kHz), the second clock pulse changes the binary word, which means the end of the trigger pulse. (See Figure 4–2)

4–35 This pulse is not generated when A2S1 is set to "Test" In this case flip-flops 1 through 10 generate a periodic pattern of 1023 different binary 10-bit words. Here the output levels of flip-flops 7 and 10 are sensed by the second "exclusive or" gate contained in MC17, and the resulting binary output (pin 8) is fed back to flip-flop 1.

4–36 DIGITAL TO ANALOG CONVERTERS (P/O A2)

4–37 Each shift register flip-flop feeds a Digital to Analog (D/A) Converter stage – flip-flops 8 and 25 excepted. Operating voltage (11.7 V) is supplied by A3-Q23 through Q25. All Converter stages are working in parallel. The first and the last seven are linked to the Q–outputs of the corresponding flip-flops. Converter stages 8 through 23 are connected to the $\overline{Q}$–outputs of flip-flops 9 through 24. So there are 30 single D/A Converter stages, of which the first and the last (Q1 and Q30), the second (Q2) and the one before last (Q29) etc. are identical. Hence, the complete Converter setup is symmetrical as shown in Figure 4–3. The summarized current (pin 10) from all converter stages is fed to the Summing Amplifier.

4–38 SUMMING AMPLIFIER (P/O A3)

4–39 The Summing Amplifier incorporates Q1 through Q8. The output signal from the D/A Convertors alternates above zero (positive), this "offset" is compensated by R2, so that the amplified signal at the output of the Summing Amp alternates around the desired zero line as shown in Figure 4–3.

4–40 The input stage (Q1) of the amplifier is a differential ampplifier with a balancing resister between both collectors (R5). This way the different bias currents of Q3 and Q4 have less effect on the signal amplitude at the collectors. The following differential stage (Q3/Q4) provides an additional amplification. From the collector of Q4 the signal is fed to amplifier Q5.

4–41 For high frequencies there is a more convenient way via C1 to Q6. Transistors Q5 and Q6 feed the output emitter followers Q7 and Q8, which are forward biased by CR1 and CR2. The amount of the overall negative feedback is determined by R12 and R65; with R65 PINK noise gain is adjusted.

4–42 SMOOTHING FILTER (P/O A3)

4–43 Basically, the Smoothing Filter is identical to the Summing Amplifier. The Output signal from the Summing Amplifier is filtered by R19/C4 and R20/C5. In WHITE noise generation the bias of Q9B is grounded via R69 and a switch contact on A7. Via the same contact there is a constant current flow towards –15 V (via A7R1), preventing high contact resistance caused by corrosion.

4–44 The output stage consists of Q15 through Q18. While the output voltage comes from Q15 and Q16 via R37/R38, the output current is supplied by Q17 and Q18. The output impedance is 50 Ω, determined by R40/R42.

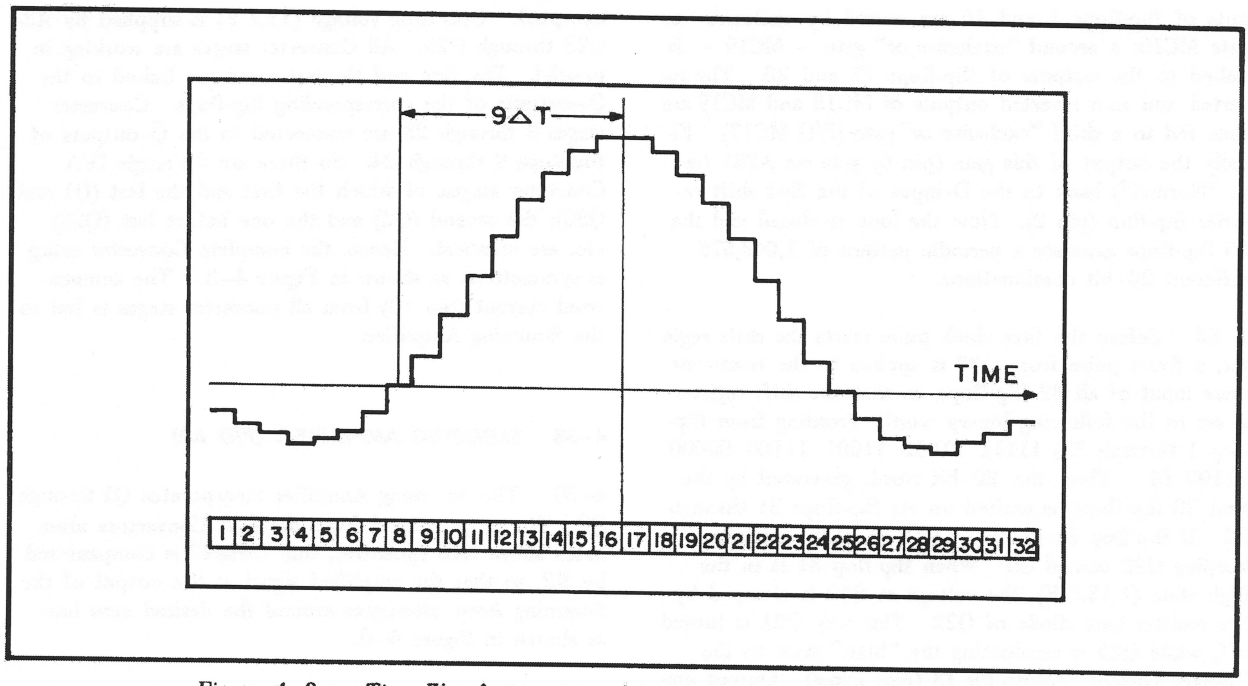


Figure 4–3. Time Waveform generated by a single '1' shifted thru the register

4–45 The differences between WHITE and PINK noise generation are:

1. WHITE
   a. The signal from the summing amplifier is dc coupled to the Smoothing Filter.
   b. The overall feedback path of the Smoothing Filter leads via R68/67, WHITE noise gain is adjusted by R68.
2. PINK
   a. Capacitors C12/C13 couple the Summing Amplifier output to the Smoothing Filter.
   b. The feedback path of the Smoothing Filter leads via an RC network consisting of R43 through R52 and C15 through C23. The impedance of this network decreases by 3 dB/octave as the frequency increases.

4–46 ATTENUATORS A4, A5, A6

4–47 The noise signal coming from the Smoothing Filter first is applied to the 0.1 dB step Attenuator A6, which attenuates the signal between zero and 0.9 dB in 0.1 dB steps. Attenuator A5 decreases the noise in ten dB steps to a maximum of 9 dB. The attenuation range of A4 finally goes from 0 to 100 dB in 10 dB steps. The front-panel dB indication represents the dB level of the output voltage referred to 1 μV. From A6 the noise gets to the front-panel OUTPUT connector via output selection switch S2 and the impedance switch contacts (P/O A7).

4–48 POWER SUPPLY (A1)

4–49 Power supply assembly A1 provides the necessary operating voltages for the noise generator circuits. Since both positive and negative 15 volt supplies are completely identical, only the positive 15 volt supply will be discussed.

4–50 Rectifiers CR1 through CR4 supply unregulated + 35 volts to the regulator circuit. Transistors Q5 and Q6 comprise a differential amplifier which compares a preset voltage level, adjustable by R10, to ground. Any variation of the + 15 volt output is sensed by Q5 and Q6 to produce an error signal which is amplified by Q3 and Q1. The amplified error signal is then used to control the conduction of series regulator Q2. When + 15 V increases, the conduction of Q2 decreases and conversely when the + 15 V decreases, the conduction of Q2 increases.

4–51 Current limiter Q4 is reverse biased under normal operating conditions. Should the load current exceed approximately 400 mA, Q4 is turned on by the voltage drop across R4. With Q4 turned on, there is no base current left for Q1, so that Q1 is turned off. This drives series regulator Q2 to near cut-off, thereby limiting the current drawn from the supply.

4–52 The output voltage is adjustable (R10) and referenced to avalanche diode CR6. A negative 5 volt supply is connected to the + 15 volt supply, providing + 10 volts for the shift register flip-flops. Variations of the output are sensed and amplified by Q14, which controls the driver (Q12) for the series regulator Q13. Current limiter Q15 works just like Q4 which was described above. NOTE: + 10 volts must not be loaded against ground!

SECTION V

MAINTENANCE

5–1 INTRODUCTION

5–2 This section provides maintenance and service information for the Model 8057A. It also includes performance checks, troubleshooting, and repair informations.

5–3 TEST EQUIPMENT

5–4 Test equipment required for maintaining and checking the performance of the Model 8057A is listed in Table 5–1. Test equipment having characteristics similar to those listed in the Table may be substituted for the performance checks.

5–5 INSTRUMENT COVER REMOVAL

5–6 The top, bottom and side covers are separately removable. Each cover is held in place by screws which thread into fasteners attached to the instrument side castings. Removal of the top cover provides access to all boards.

5–7 PERFORMANCE CHECKS

5–8 The performance checks verify whether or not the Model 8057A is operating within the specifications as stated in Table 1–1. These checks may be used as part of an incoming quality control inspection, as a periodic operational check or after repairs have been made. Recently calibrated equipment should be used when performing these checks.

Table 5–1. Required Test Equipment

Recommended Instrument		Required Characteristics
Type	Model	
Pulse Generator	HP 8003A	Pulse Rate: > 1 MHz Pulse Width: ⩾ 30 ns Amplitude: 0 to +5 V
Counter	HP 5245L	Max. frequency: > 1 MHz Ext. Time Base Facility): 1 MHz Sensitivity: 1 V
Oscilloscope	HP 140A	
Horiz. Amp.	HP 1423A	Max. Trigger Frequency: 20 MHz Sweep Time: 20 ns/cm
Vertic. Amp.	HP 1402A	Frequency Range: dc to 20 MHz Sensitivity: 0.1 V/cm
Wave Analyzer	HP 302A	Frequency Range: 20 Hz to 40 kHz Selectivity: ± 25 Hz 50 dB down

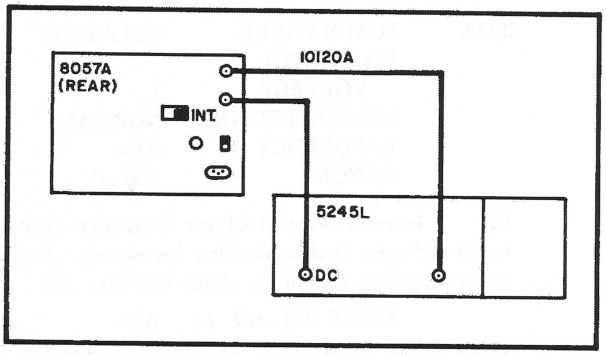


Figure 5–1. Sequence Length Test Setup

5–9 SEQUENCE LENGTH CHECK

a. Connect equipment as shown in Figure 5–1.

b. Set controls as follows:

8057A	CLOCK SEL. SW.	INT.
5245L	FUNCTION SW.	PERIOD AVERAGE x 1
	TIME BASE SW.	EXT.
	SENSITIVITY	1 V rms

c. 5245L display should indicate

$$\frac{1{,}048{,}576}{4} = 262{,}144$$

5–10 CLOCK FREQUENCY CHECK

a. Connect equipment as shown in Figure 5–2.

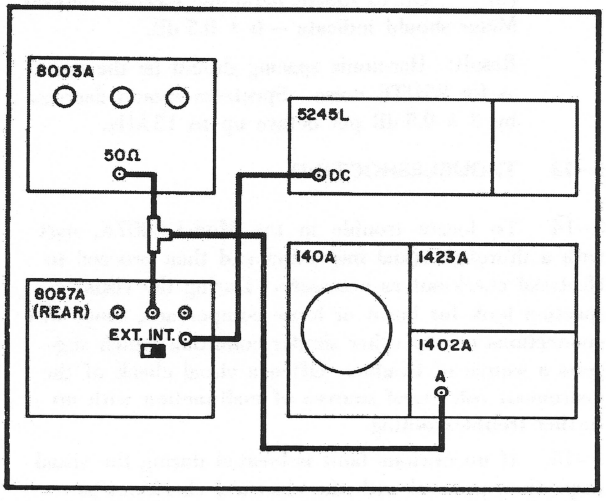


Figure 5–2. Clock Frequency Test Setup

b. INTERNAL FREQUENCY CHECK

Set controls as follows:

8057A	CLOCK SEL. SW.	INT.
5245L	FUNCTION	PERIOD AVERAGE x 1
	TIME BASE	1 msec
	SENSITIVITY	1 V rms

Counter should indicate 2016 ± 20 msec.

c. EXTERNAL FREQUENCY CHECK

Set controls as follows:

8057A	CLOCK SEL. SW.	EXT.
8003A	REP. RATE	10 MHz
	VERNIER	CCW
	PULSE WIDTH	30 nsec
	VERNIER	CCW
	AMPLITUDE	5 V
1420A	TRIGGER	INT +
	MAGNIFIER	x 1
	SWEEP TIME	0.5 μsec
1402A	FUNCTION	A
	POLARITY	+
	CHANNEL A INPUT	ON
	COUPLING	DC
	SENSITIVITY	0.5 V/cm
5245L	Same as 5–10 b.	

Counter reading (Time) should correspond to Trigger Pulse Repetition Rate. $\Delta T = \frac{1{,}048{,}575}{\text{Trigger Freq.}}$;

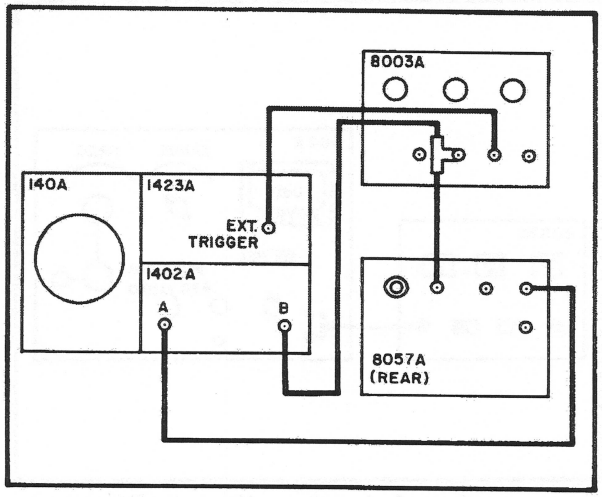


Figure 5–3. Gated Operation Setup

5–11 GATED OPERATION CHECK

a. Connect equipment as shown in Figure 5–3.

b. Set controls as follows:

8057A	CLOCK SEL. SW.	INT.
8003A	REP. RATE	0.3 MHz
	VERNIER	CCW
	PULSE WIDTH	0.1 msec.
	VERNIER	CCW
	AMPLITUDE	+ 2.5 V
1420A	TRIGGER	EXT.
	SWEEP TIME	20 μsec.
1402A	FUNCTION	ALT.
	POLARITY	+
	CHANNEL A	5 V/cm
		DC coupled
	CHANNEL B	1 V/cm
		DC coupled

Binary output signal should be enabled when Gate amplitude is > + 4.5 V and disabled when < 2.8 V.

5–12 NOISE CHECK

a. WHITE NOISE LINEARITY

(1) Set controls as follows:

8057A	ATTENUATOR	129.9 dB
	NOISE	WHITE
	IMPEDANCE	600 Ω
Remove top cover and set		
	A2S1 to	T

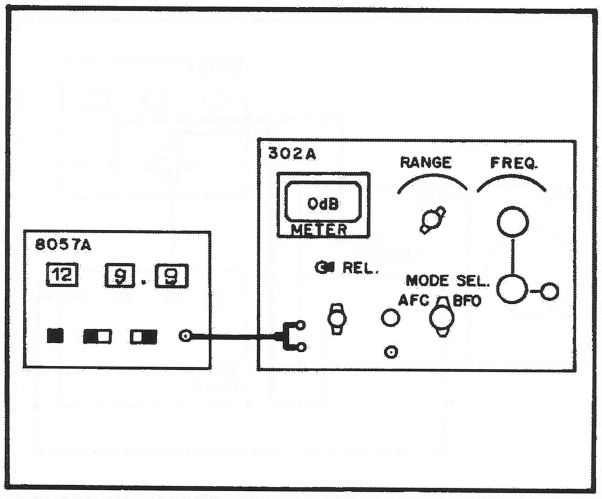


Figure 5–4. Noise Check Setup

302A	SCALE VALUE	RELATIVE
	MAX. INPUT VOLTAGE	1
	MODE SELECTOR	NORMAL
	FREQUENCY	0 Hz
	RANGE	300 mV

(2) Increase Wave Analyzer frequency until meter indicates first peak (first harmonic). Frequency reading should be about 500 Hz. Set

MODE SEL. SW. to AFC.

Meter needle "locks in". Use Vernier of Max. Input Voltage selector in setting meter needle to 0 dB mark.

(3) Set MODE SEL. to NORMAL
Find second harmonic by increasing Wave Analyzer frequency until next meter peak appears.
Set MODE SEL. back to AFC.
Meter should indicate 0 ± 0.3 dB. Harmonic spacing should be about 500 Hz.

(4) Continue checking linearity and harmonic spacing up to 27 kHz as described under step (3).

b. PINK NOISE

Change the following controls:

8057A	Noise	PINK
302A	MAX. INPUT VOLTAGE:	3

(1) Set Wave Analyzer frequency to first harmonic as outlined under 5–12 a. (2).

(2) Go to second harmonic (first octave). Meter should indicate – 3 ± 0.5 dB.

(3) Go to fourth harmonic (second octave). Meter should indicate – 6 ± 0.5 dB.

Result: Harmonic spacing should be the same as for WHITE noise. Spectrum should decrease by 3 ± 0.5 dB per octave up to 15 kHz.

5–13 TROUBLESHOOTING

5–14 To locate trouble in the Model 8057A, start with a thorough visual inspection and then proceed to electrical check-out as necessary. During the visual inspection look for burnt or loose components, loose wire connections or any other similar condition which suggests a source of trouble. Often a visual check of the instrument will reveal sources of malfunction with no further troubleshooting.

5–15 If no obvious fault is located during the visual inspection, proceed with the electrical check-out as shown in the troubleshooting flow chart on Figure 5–5.

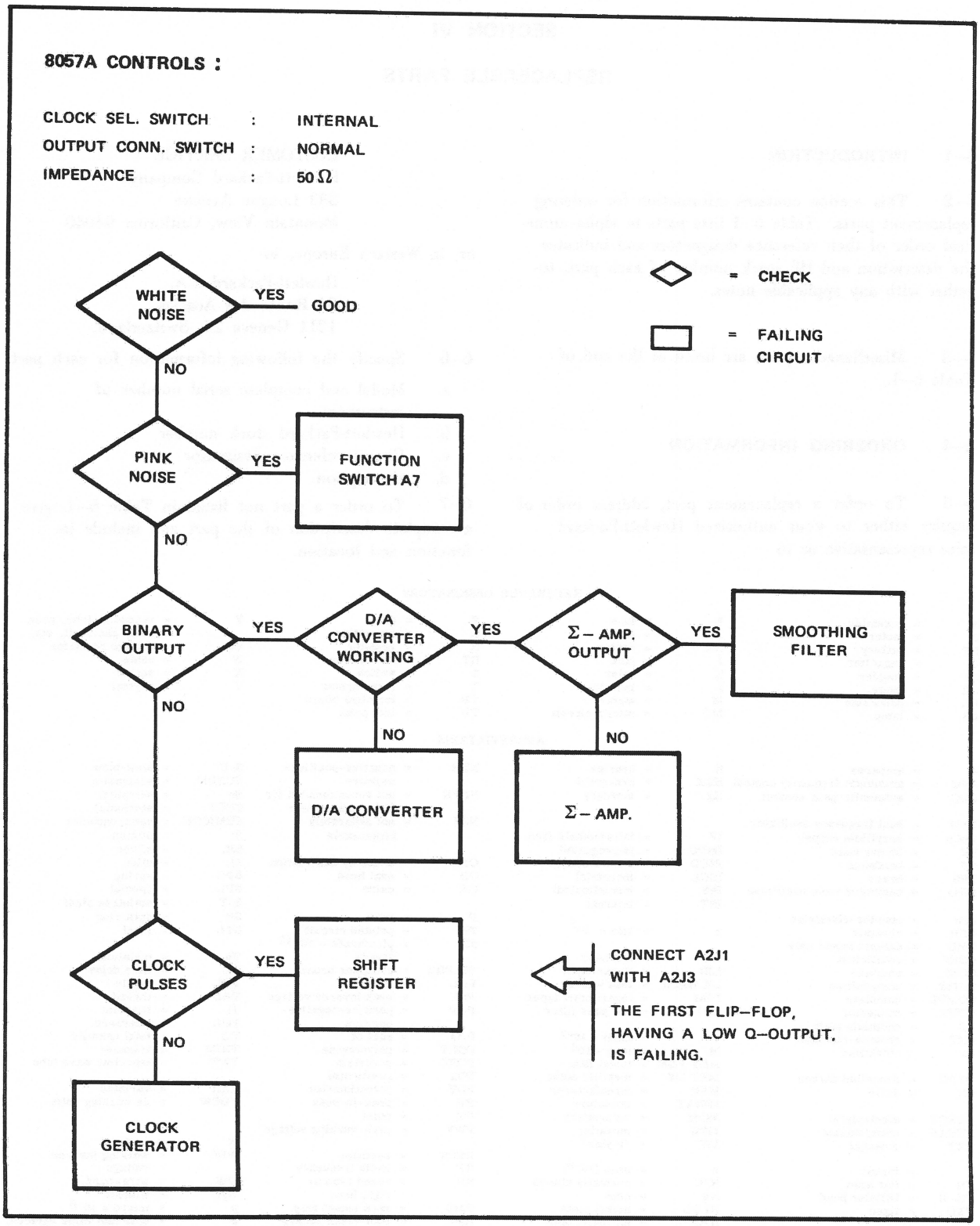


Figure 5–5. Troubleshooting Chart

SECTION VI

REPLACEABLE PARTS

6–1 INTRODUCTION

6–2 This section contains information for ordering replacement parts. Table 6–1 lists parts in alpha-numerical order of their reference designators and indicates the description and HP stock number of each part, together with any applicable notes.

6–3 Miscellaneous parts are listed at the end of Table 6–1.

6–4 ORDERING INFORMATION

6–5 To order a replacement part, address order of inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
333 Longue Avenue
Mountain View, California 94040

or, in Western Europe, to

Hewlett-Packard S.A.
54 Route des Acacias
1211 Geneva 24, Switzerland.

6–6 Specify the following information for each part

a. Model and complete serial number of instrument
b. Hewlett-Packard stock number
c. Circuit reference designator
d. Description.

6–7 To order a part not listed in Table 6–1, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vaccuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor		
BT	= battery	HR	= heater	R	= resistor	VR	= voltage regulator
C	= capacitor	J	= jack	RT	= thermistor	W	= cable
CP	= coupler	K	= relay	S	= switch	X	= socket
CR	= diode	L	= inductor	T	= transformer	Y	= crystal
DL	= delav line	M	= meter	TB	= terminal board		
DS	= lamp	MC	= micro-circuit	TP	= test point		

ABBREVIATIONS

A	= amperes	H	= henries	NPN	= negative-positive-negative	S-B	= slow-blow
AFC	= automatic frequency control	HEX	= hexagonal	NRFR	= not recommended for field replacement	SCHEM.	= schematic
AGC	= automatic gain control	Hg	= mercury	NSR	= not separately replaceable	Se	= selenium
BFO	= beat frequency oscillator					SECT	= section(s)
BeCu	= beryllium copper	IF	= intermediate freq.			SEMICON	= semiconductor
BH	= binder head	IMPG	= impregnated			Si	= silicon
BP	= bandpass	INCD	= incandescent	OBD	= order by description	SIL	= silver
BRS	= brass	INCL	= include(s)	OH	= oval head	SL	= slide
BWO	= backward wave oscillator	INS	= insulation(ed)	OX	= oxide	SPG	= spring
		INT	= internal			SPL	= special
ccw	= counter-clockwise			P	= peak	SST	= stainless steel
CER	= ceramic	k	= kilo = 10^3	PC	= printed circuit	SR	= split ring
CMO	= cabinet mount only			pF	= picofarads = 10^{-12} farads	STL	= steel
COEF	= coefficient	LH	= left hand			Ta	= tantalum
COM	= common	LIN	= linear taper	PH BRZ	= phosphor bronze	TD	= time delay
COMP	= composition	LK WASH	= lock washer	PHL	= Philips	TGL	= toggle
COMPL	= complete	LOG	= logarithmic taper	PIV	= peak inverse voltage	THD	= thread
CONN	= connector	LPF	= low pass filter	PNP	= positive-negative-positive	Ti	= titanium
CP	= cadmium plate			P/O	= part of	TOL	= tolerance
CRT	= cathode-ray tube	m	= milli = 10^{-3}	POLY	= polystyrene	TQ	= total quantity
cw	= clockwise	M	= meg = 10^6	PORC	= porcelain	TRIM	= trimmer
		MET FLM	= metal film	POS	= position(s)	TWT	= traveling wave tube
DEPC	= deposited carbon	MET OX	= metallic oxide	POT	= potentiometer		
DR	= drive	MFR	= manufacturer	PP	= peak-to-peak	VAR	= variable
		MINAT	= miniature	PT	= point	VDCW	= dc working volts
ELECT	= electrolytic	MOM	= momentary	PWV	= peak working voltage		
ENCAP	= encapsulated	MTG	= mounting			W	= watts
EXT	= external	MY	= "mylar"	RECT	= rectifier	WIV	= working inverse voltage
F	= farads	n	= nano (10^{-9})	RF	= radio frequency	WW	= wirewound
FH	= flat head	N/C	= normally closed	RH	= round head or right hand	W/O	= without
FIL H	= fillister head	Ne	= neon	RMO	= rack mount only	μ	= micro = 10^{-6}
FXD	= fixed	Ni PL	= nickel plate	RMS	= root-mean square	*	= optimum value selected at factory, average value shown (part may be omitted)
		N/O	= normally open	RS	= recommended spares		
Ge	= germanium	NPO	= negative positive zero (zero temperature coefficient)	RWV	= reverse working voltage		
GRD	= ground(ed)						

Table 6-1. Reference Designation Index

Reference Designation	Part No.	Description #
A 1	08057-66501	POWER SUPPLY,PC ASSY
A 1 C 1	0180- 1723	C FXD AL ELECT 500 UF +75-10% 50VDC
A 1 C 2	0180- 0196	C FXD TA ELECT 56 UF 10% 15VDCW
A 1 C 3	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 1 C 4	0180- 0098	C FXD TA ELECT 100 UF 20% 20VDCW
A 1 C 5	0180- 1723	C FXD AL ELECT 500 UF +75-10% 50VDC
A 1 C 6	0180- 0196	C FXD TA ELECT 56 UF 10% 15VDCW
A 1 C 7	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 1 C 8	0180- 0098	C FXD TA ELECT 100 UF 20% 20VDCW
A 1 C 9	0180- 0237	C FXD AL ELECT 500 UF +75-10% 25VDC
A 1 C 10	0150- 0096	C FXD CER .05 UF +80-20% 100VDCW
A 1 C 11	0180- 0137	C FXD TA ELECT 100 UF 20% 10VDCW
A 1 C 12	0180 021	C FXD AL ELECT 250 UF +15 10% 12VDC
A 1 C 13	0160- 2147	C FXD CER .025 UF +80-20% 100VDCW
A 1 C 14	0160- 2147	C FXD CER .025 UF +80-20% 100VDCW
A 1 CR 1	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 2	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 3	1901 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 4	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 5	1902- 3107	DIODE BREAKDOWN 5.76V 2% 400 MW
A 1 CR 6	1902- 0041	DIODE BREAKDOWN 5.11V 5% 400 MW
A 1 CR 7	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 8	1901- 0194	DIODE SILICON 50PIV 750 MA
A CR 9	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 10	1901- 0194	DIODE SILICON 50PIV 750 MA
A CR 11	1902- 3107	DIODE BREAKDOWN 5.76V 2% 400 MW
A 1 CR 12	1902 0041	DIODE BREAKDOWN 5.11V 5% 400 MW
A 1 CR 13	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 14	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 15	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 16	1901- 0194	DIODE SILICON 50PIV 750 MA
A 1 CR 17	1902- 0188	DIODE BREAKDOWN 4.12V 5% 400 MW
A 1 J 1	1251 0213	CONNECTOR P C 15-CONTACT
1 J 2	1251- 1513	CONNECTOR P C 18-CONTACT
A 1 Q 1	1854- 0022	TRANS STOR ,I I ON N N
A 1 Q 2	1854- 0072	TRANSISTOR SILICON NPN 2N3054
A 1 Q 3	1854- 0329	TRANSISTOR SILICON NPN
A 1 Q 4	1854- 0329	TRANSISTOR SILICON NPN
A 1 Q 5	1854- 0307	TRANSISTOR SILICON NPN
A 1 Q 6	1854- 0307	TRANSISTOR SILICON NPN
A 1 Q 7	1854- 0022	TRANSISTOR SILICON NPN
A 1 Q 8	1854- 0072	TRANSISTOR SILICON NPN 2N3054
A 1 Q 9	1854- 0329	TRANSISTOR SILICON NPN
A 1 Q 10	1854- 0307	TRANSISTOR SILICON NPN
A 1 Q 11	1854- 0307	TRANSISTOR SILICON NPN
A 1 Q 12	1854- 0307	TRANSISTOR SILICON NPN
A 1 Q 13	1854- 0072	TRANSISTOR SILICON NPN 2N3054
A 1 Q 14	1854- 0329	TRANSISTOR SILICON NPN
A 1 Q 15	1854- 0307	TRANSISTOR SILICON NPN
A 1 Q 16	1854- 0329	TRANSISTOR SILICON NPN
A 1 R 1	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 1 R 2	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 1 R 3	0698- 4248	R FXD FLM 560 OHM 5% 1/4W
A 1 R 4	0727- 0001	R FXD CARB FLM 1.5 OHM 2% 1/2W
A 1 R 5	0698- 4248	R FXD FLM 560 OHM 5% 1/4W

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 1 R 6	0698- 4290	R FXD FLM 33K OHM 5% 1/4W
A 1 R 7	0698- 4282	R FXD FLM 15K OHM 5% 1/4W
A 1 R 8	0698- 4290	R FXD FLM 33K OHM 5% 1/4W
A 1 R 9	0698- 4253	R FXD FLM 910 OHM 5% 1/4W
A 1 R 10	2100- 2739	R VAR VERMET 220 OHM 20% .5W
A 1 R 11	0698- 4245	R FXD FLM 390 OHM 5% 1/4W
A 1 R 12	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 1 R 13	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 1 R 14	0698- 4248	R FXD FLM 560 OHM 5% 1/4W
A 1 R 15	0698- 4248	R FXD FLM 560 OHM 5% 1/4W
A 1 R 16	0698- 4290	R FXD FLM 33K OHM 5% 1/4W
A 1 R 17	0698- 4282	R FXD FLM 15K OHM 5% 1/4W
A 1 R 18	0698- 4290	R FXD FLM 33K OHM 5% 1/4W
A 1 R 19	0698- 4253	R FXD FLM 910 OHM 5% 1/4W
A 1 R 20	2100- 2739	R VAR VERMET 220 OHM 20% .5W
A 1 R 21	0698- 4245	R FXD FLM 390 OHM 5% 1/4W
A 1 R 22	0698- 4235	R FXD FLM 150 OHM 5% 1/4W
A 1 R 23	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 1 R 24	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 1 R 25	0727- 0001	R FXD CARB FLM 1.5 OHM 2% 1/2W
A 1 R 26	0758- 0124	R FXD FLM 51 OHM 5% 1/4W
A 1 R 27	0698- 6744	R FXD FLM 20 OHM 5% 1/4W
A 1 R 28	2100- 2796	R VAR VERMET 100 OHM 20% 1/2W
A 1 R 29	0698- 4245	R FXD FLM 390 OHM 5% 1/4W
A 1 R 30	0698- 4258	R FXD FLM 1500 OHM 5% 1/4W
A 1 R 32	0727- 0001	R FXD CARB FLM 1.5 OHM 2% 1/2W
A 1 RT 1	0837- 0015	THERMISTOR 500 OHM
A 2	08057-66502	SHIFT REGISTER/D-A
	-	CONVERTER,P.C. ASSY
A 2 C 2	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 2 C 3	0140- 0157	C FXD MICA 1857 PF 1% 500VDCW
A 2 C 4	0160- 0153	C FXD MYLAR 1000 PF 10% 200VDCW
A 2 C 5	0160- 2265	C FXD CER 22 PF 5% 500VDCW
A 2 C 6	0160- 0174	C FXD CER .47 UF +80-20% 25VDCW
A 2 C 7	0150- 0121	C FXD CER .1UF +80%-20% 50VDCW
A 2 C 8	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 2 C 9	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 2 C 10	0140- 0196	C FXD MICA 150PF 5% 500VDCW
A 2 CR 1	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 2	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 3	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 4	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 5	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 6	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 7	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 8	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 9	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 10	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 11	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 12	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 13	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 14	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 15	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 16	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 17	1901- 0040	DIODE SILICON 30PIV 30 MA

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 2 CR 18	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 19	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 20	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 21	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 22	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 23	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 24	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 25	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 26	1910- 0034	DIODE GERMANIUM 25 PIV 100 MA
A 2 CR 27	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 28	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 29	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 30	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 31	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 32	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 33	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 34	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 CR 35	1901- 0040	DIODE SILICON 30PIV 30 MA
A 2 L 1	9140- 0111	COIL FXD RF 3.3 UH
A 2 MC 1	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 2	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 3	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 4	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 5	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 6	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 7	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 8	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 9	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 10	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 11	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 12	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 13	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 14	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 15	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 16	1820- 0077	INTEGRATED CIRC.DUAL D FLIP FLOP
A 2 MC 17	1820- 0063	INTEGRATED CIR DUAL EXOR GATE
A 2 MC 18	1820- 0054	INTEGRATED CIR QUAD 2 INPUT GATE
A 2 MC 19	1820- 0054	INTEGRATED CIR QUAD 2 INPUT GATE
A 2 Q 1	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 2	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 3	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 4	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 5	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 6	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 7	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 8	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 9	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 10	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 11	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 12	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 13	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 14	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 15	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 16	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 17	1853- 0229	TRANSISTOR SILICON PNP

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 2 Q 18	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 19	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 20	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 21	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 22	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 23	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 24	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 25	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 26	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 27	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 28	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 29	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 30	1853- 0229	TRANSISTOR SILICON PNP
A 2 Q 34	1853- 0090	TRANSISTOR SILICON PNP
A 2 Q 35	1855- 0010	TRANSISTOR SILICON UNIJUNC 2N2646
A 2 Q 36	1854- 0307	TRANSISTOR SILICON NPN
A 2 Q 37	1854- 0307	TRANSISTOR SILICON NPN
A 2 Q 38	1853- 0090	TRANSISTOR SILICON PNP
A 2 Q 39	1854- 0019	TRANSISTOR SILICON NPN
A 2 Q 40	1854- 0329	TRANSISTOR SILICON NPN
A 2 Q 41	1853- 0036	TRANSISTOR SILICON PNP 2N3906
A 2 Q 42	1854- 0307	TRANSISTOR SILICON NPN
A 2 Q 43	1854- 0307	TRANSISTOR SILICON NPN
A 2 Q 44	1854- 0019	TRANSISTOR SILICON NPN
A 2 Q 45	1854- 0019	TRANSISTOR SILICON NPN
A 2 Q 46	1854- 0019	TRANSISTOR SILICON NPN
A 2 R 1	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 2	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 3	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 4	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 5	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 6	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 7	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 8	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 9	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 10	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 11	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 12	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 13	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 14	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 15	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 16	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 17	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 18	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 19	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 20	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 21	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 22	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 23	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 24	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 25	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 26	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 27	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 28	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 29	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W
A 2 R 30	0698- 4257	R FXD FLM 1300 OHM 5% 1/4W

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 2 R 31	0757- 0484	R FXD MET FLM 619K OHM 1% 1/8W
A 2 R 32	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 33	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 34	0698- 5797	R FXD MET FLM 296K OHM 1% 1/8W
A 2 R 35	0698- 5796	R FXD MET FLM 186K OHM 1% 1/8W
A 2 R 36	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 37	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 38	0698- 5795	R FXD MET FLM 138K OHM .5% 1/8W
A 2 R 39	0757- 0467	R FXD MET FLM 121K OHM 1% 1/8W
A 2 R 40	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 41	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 42	0757- 0469	R FXD MET FLM 150K OHM 1% 1/8W
A 2 R 43	0757- 0472	R FXD MET FLM 200K OHM 1% 1/8W
A 2 R 44	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 45	0757- 0467	R FXD MET FLM 121K OHM 1% 1/8W
A 2 R 46	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 47	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 48	0698- 5794	R FXD MET FLM 52.6K OHM .5% 1/8W
A 2 R 49	0698- 5793	R FXD MET FLM 31.1K OHM .5% 1/8W
A 2 R 50	0698- 4282	R FXD FLM 15K OHM 5% 1/4W
A 2 R 51	0698- 4284	R FXD FLM 18K OHM 5% 1/4W
A 2 R 52	0698- 6888	R FXD MET FLM 21.3K OHM .5% 1/8W
A 2 R 53	0698- 6880	R FXD MET FLM 16K OHM .5% 1/8W
A 2 R 54	0698- 4288	R FXD FLM 27K OHM 5% 1/4W
A 2 R 55	0698- 6877	R FXD MET FLM 12.9K OHM .5% 1/8W
A 2 R 56	0698- 5789	R FXD MET FLM 11.1K OHM .5% 1/8W
A 2 R 57	0698- 6871	R FXD MET FLM 10K OHM .5% 1/8W
A 2 R 58	0698- 6871	R FXD MET FLM 10K OHM .5% 1/8W
A 2 R 59	0698- 5789	R FXD MET FLM 11.1K OHM .5% 1/8W
A 2 R 60	0698- 6877	R FXD MET FLM 12.9K OHM .5% 1/8W
A 2 R 61	0698- 4288	R FXD FLM 27K OHM 5% 1/4W
A 2 R 62	0698- 6880	R FXD MET FLM 16K OHM .5% 1/8W
A 2 R 63	0698- 4284	R FXD FLM 18K OHM 5% 1/4W
A 2 R 64	0698- 6888	R FXD MET FLM 21.3K OHM .5% 1/8W
A 2 R 65	0698- 4282	R FXD FLM 15K OHM 5% 1/4W
A 2 R 66	0698- 5793	R FXD MET FLM 31.1K OHM .5% 1/8W
A 2 R 67	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 68	0698- 5794	R FXD MET FLM 52.6K OHM .5% 1/8W
A 2 R 69	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 70	0757- 0467	R FXD MET FLM 121K OHM 1% 1/8W
A 2 R 71	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 72	0757- 0472	R FXD MET FLM 200K OHM 1% 1/8W
A 2 R 73	0757- 0469	R FXD MET FLM 150K OHM 1% 1/8W
A 2 R 74	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 75	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 76	0757- 0467	R FXD MET FLM 121K OHM 1% 1/8W
A 2 R 77	0698- 5795	R FXD MET FLM 138K OHM .5% 1/8W
A 2 R 78	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 79	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 80	0698- 5796	R FXD MET FLM 186K OHM 1% 1/8W
A 2 R 81	0698- 5797	R FXD MET FLM 296K OHM 1% 1/8W
A 2 R 82	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 83	0698- 4278	R FXD FLM 10K OHM 5% 1/4W
A 2 R 84	0757- 0484	R FXD MET FLM 619K OHM 1% 1/8W
A 2 R 90	0758- 0125	R FXD FLM 430 OHM 5% 1/4W
A 2 R 92	0698- 4254	R FXD FLM 1000 OHM 5% 1/4W

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd.)

Reference Designation	Part No.	Description #
A 2 R 93	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 2 R 94	0698- 4258	R FXD FLM 1500 OHM 5% 1/4W
A 2 R 95	0698- 4235	R FXD FLM 150 OHM 5% 1/4W
A 2 R 96	0758- 0124	R FXD FLM 51 OHM 5% 1/4W
A 2 R 97	0698- 4255	R FXD FLM 1100 OHM 5% 1/4W
A 2 R 98	0698- 4254	R FXD FLM 1000 OHM 5% 1/4W
A 2 R 99	0698- 4271	R FXD FLM 5100 OHM 5% 1/4W
A 2 R 100	0698- 4265	R FXD FLM 3000 OHM 5% 1/4W
A 2 R 101	0698- 4242	R FXD FLM 300 OHM 5% 1/4W
A 2 R 102	0757- 0437	R FXD MET FLM 4750 OHM 1% 1/8W
A 2 R 103	0757- 0438	R FXD MET FLM 5110 OHM 1% 1/8W
A 2 R 104	0698- 4264	R FXD FLM 2700 OHM 5% 1/4W
A 2 R 105	0758- 0125	R FXD FLM 430 OHM 5% 1/4W
A 2 R 106	0757- 0430	
A 2 R 106	0757- 0430	R FXD MET FLM 2210 OHM 1% 1/8W
A 2 R 107	0698- 4258	R FXD FLM 1500 OHM 5% 1/4W
A 2 R 108	0698- 4247	R FXD FLM 510 OHM 5% 1/4W
A 2 R 109	0757- 0407	R FXD MET FLM 200 OHM 1% 1/8W
A 2 R 110	0698- 4252	R FXD FLM 820 OHM 5% 1/4W
A 2 R 111	0698- 4269	R FXD FLM 4300 OHM 5% 1/4W
A 2 R 112	0698- 4269	R FXD FLM 4300 OHM 5% 1/4W
A 2 R 113	0698- 4265	R FXD FLM 3000 OHM 5% 1/4W
A 2 R 114	0698- 4254	R FXD FLM 1000 OHM 5% 1/4W
A 2 R 115	0757- 0430	R FXD MET FLM 2210 OHM 1% 1/8W
A 2 R 116	0757- 0273	R FXD MET FLM 3010 OHM 1% 1/8W
A 2 R 117	0758- 0125	R FXD FLM 430 OHM 5% 1/4W
A 2 R 119	0757- 0824	R FXD MET FLM 2000 OHM 1% 1/2W
A 2 R 120	0757- 0408	R FXD MET FLM 243 OHM 1% 1/8W
A 2 R 122	0698- 4254	R FXD FLM 1000 OHM 5% 1/4W
A 2 R 123	0698- 4254	R FXD FLM 1000 OHM 5% 1/4W
A 2 R 124	0698- 4259	R FXD FLM 1600 OHM 5% 1/4W
A 2 R 125	0698- 4254	R FXD FLM 1000 OHM 5% 1/4W
A 2 R 126	2100- 2777	R VAR VERMET 1 KOHM 20% 1/2W
A 2 S 1	08057-21901	SWITCH SLIDE
A 3	08057-66503	SUMMING AMP./
	-	SMOOTHING FLT. P.C. ASSY
A 3 C 1	0160- 0153	C FXD MYLAR 1000 PF 10% 200VDCW
A 3 C 2	0160- 2257	C FXD CER 10 PF 5% 500VDCW
A 3 C 3	0180- 1743	C FXD TA ELECT .1 UF 10% 35VDCW
A 3 C 4	0160- 2228	C FXD MICA 2700 PF 5% 300VDCW
A 3 C 5	0160- 2210	C FXD MICA 470 PF 5% 300VDCW
A 3 C 6	0160- 2257	C FXD CER 10 PF 5% 500VDCW
A 3 C 7	0160- 0153	C FXD MYLAR 1000 PF 10% 200VDCW
A 3 C 8	0180- 1743	C FXD TA ELECT .1 UF 10% 35VDCW
A 3 C 9	0150- 0121	C FXD CER .1UF +80%-20% 50VDCW
A 3 C 10	0150- 0121	C FXD CER .1UF +80%-20% 50VDCW
A 3 C 12	0180- 0159	C FXD TA ELECT 220 UF 20% 10VDCW
A 3 C 13	0180- 0159	C FXD TA ELECT 220 UF 20% 10VDCW
A 3 C 14	0140- 0193	C FXD MICA 82 PF 5% 300VDCW
A 3 C 15	0160- 2218	C FXD MICA 1000 PF 5% 300VDCW
A 3 C 16	0140- 0157	C FXD MICA 1857 PF 1% 500VDCW
A 3 C 17	0160- 2127	C FXD MICA 4600 PF 1% 300VDCW
A 3 C 18	0160- 2151	C FXD MYLAR .011 UF 5% 200VDCW
A 3 C 19	0160- 3385	C FXD POLYCAR .03 UF 2% 150VDC

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 3 C 20	0160- 3384	C FXD POLYCAR .072 UF 5% 160WVDC
A 3 C 21	0160- 2194	C FXD MYLAR .18 UF 5% 200VDCW
A 3 C 22	0160- 3383	C FXD POLYCAR .430 UF 2% 63WVDC
A 3 C 23	0160- 0510	C FXD POLYCAR 1 UF 10% 50VDCW
A 3 C 24	0150- 0121	C FXD CER .1UF +80%-20% 50VDCW
A 3 C 26	0160- 0174	C FXD CER .47 UF +80-20% 25VDCW
A 3 C 27	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 3 C 28	0180- 0197	C FXD TA ELECT 2.2 UF 10% 20VDCW
A 3 C 29	0150- 0093	C FXD CER .01 UF +80-20% 100VDCW
A 3 CR 1	1901- 0040	DIODE SILICON 30PIV 30 MA
A 3 CR 2	1901- 0040	DIODE SILICON 30PIV 30 MA
A 3 CR 3	1901- 0040	DIODE SILICON 30PIV 30 MA
A 3 CR 4	1901- 0040	DIODE SILICON 30PIV 30 MA
A 3 J 1	1251- 0131	CONNECTOR FEMALE SOCKET 1-CONTACT
A 3 Q 1	1854- 0221	TRANSISTOR SILICON NPN
A 3 Q 3	1854- 0307	TRANSISTOR SILICON NPN
A 3 Q 4	1854- 0307	TRANSISTOR SILICON NPN
A 3 Q 5	1853- 0036	TRANSISTOR SILICON PNP 2N3906
A 3 Q 6	1854- 0329	TRANSISTOR SILICON NPN
A 3 Q 7	1854- 0329	TRANSISTOR SILICON NPN
A 3 Q 8	1853- 0036	TRANSISTOR SILICON PNP 2N3906
A 3 Q 9	1854- 0221	TRANSISTOR SILICON NPN
A 3 Q 11	1854- 0307	TRANSISTOR SILICON NPN
A 3 Q 12	1854- 0307	TRANSISTOR SILICON NPN
A 3 Q 13	1853- 0036	TRANSISTOR SILICON PNP 2N3906
A 3 Q 14	1854- 0329	TRANSISTOR SILICON NPN
A 3 Q 15	1854- 0329	TRANSISTOR SILICON NPN
A 3 Q 16	1853- 0036	TRANSISTOR SILICON PNP 2N3906
A 3 Q 17	1853- 0027	TRANSISTOR SILICON PNP
A 3 Q 18	1854- 0090	TRANSISTOR SILICON NPN
A 3 Q 19	1854- 0019	TRANSISTOR SILICON NPN
A 3 Q 20	1854- 0019	TRANSISTOR SILICON NPN
A 3 Q 21	1853- 0034	TRANSISTOR SILICON PNP
A 3 Q 22	1853- 0034	TRANSISTOR SILICON PNP
A 3 Q 23	1853- 0090	TRANSISTOR SILICON PNP
A 3 Q 24	1854- 0307	TRANSISTOR SILICON NPN
A 3 Q 25	1853- 0090	TRANSISTOR SILICON PNP
A 3 R 1	0698- 4252	R FXD FLM 820 OHM 5% 1/4W
A 3 R 2	2100- 2787	R VAR VERMET 220 OHM 20% 1/2W
A 3 R 3	0698- 0085	R FXD MET FLM 2610 OHM 1% 1/8W
A 3 R 4	0757- 0467	R FXD MET FLM 121K OHM 1% 1/8W
A 3 R 5	0698- 4286	R FXD FLM 22K OHM 5% 1/4W
A 3 R 6	0698- 4306	R FXD FLM 150K OHM 5% 1/4W
A 3 R 7	0757- 0467	R FXD MET FLM 121K OHM 1% 1/8W
A 3 R 8	0698- 4252	R FXD FLM 820 OHM 5% 1/4W
A 3 R 10	0698- 4305	R FXD FLM 130K OHM 5% 1/4W
A 3 R 11	0698- 4289	R FXD FLM 30K OHM 5% 1/4W
A 3 R 12	0757- 0283	R FXD MET FLM 2000 OHM 1% 1/8W
A 3 R 13	0683- 3345	R FXD COMP 330K OHM 5% 1/4W
A 3 R 14	0698- 4289	R FXD FLM 30K OHM 5% 1/4W
A 3 R 15	0698- 4263	R FXD FLM 2400 OHM 5% 1/4W
A 3 R 16	0698- 4263	R FXD FLM 2400 OHM 5% 1/4W
A 3 R 17	0698- 6802	R FXD FLM 10 OHM 5% 1/4W
A 3 R 18	0698- 6802	R FXD FLM 10 OHM 5% 1/4W
A 3 R 19	0757- 0283	R FXD MET FLM 2000 OHM 1% 1/8W

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 3 R 20	0757- 0280	R FXD MET FLM 1000 OHM 1% 1/8W
A 3 R 23	0698- 4252	R FXD FLM 820 OHM 5% 1/4W
A 3 R 24	0698- 4304	R FXD FLM 120K OHM 5% 1/4W
A 3 R 25	0698- 4286	R FXD FLM 22K OHM 5% 1/4W
A 3 R 26	0698- 4306	R FXD FLM 150K OHM 5% 1/4W
A 3 R 27	0698- 4300	R FXD FLM 82K OHM 5% 1/4W
A 3 R 29	0698- 4269	R FXD FLM 4300 OHM 5% 1/4W
A 3 R 30	0698- 4305	R FXD FLM 130K OHM 5% 1/4W
A 3 R 31	0698- 4289	R FXD FLM 30K OHM 5% 1/4W
A 3 R 32	0683- 3345	R FXD COMP 330K OHM 5% 1/4W
A 3 R 33	0698- 4289	R FXD FLM 30K OHM 5% 1/4W
A 3 R 34	0698- 4263	R FXD FLM 2400 OHM 5% 1/4W
A 3 R 35	0698- 4263	R FXD FLM 2400 OHM 5% 1/4W
A 3 R 36	0698- 4231	R FXD FLM 91 OHM 5% 1/4W
A 3 R 37	0758- 0124	R FXD FLM 51 OHM 5% 1/4W
A 3 R 38	0758- 0124	R FXD FLM 51 OHM 5% 1/4W
A 3 R 39	0698- 4231	R FXD FLM 91 OHM 5% 1/4W
A 3 R 40	0757- 0401	R FXD MET FLM 100 OHM 1% 1/8W
A 3 R 42	0757- 0401	R FXD MET FLM 100 OHM 1% 1/8W
A 3 R 43	0698- 4097	R FXD MET FLM 94.8 OHM 1% 1/8W
A 3 R 44	0757- 0411	R FXD MET FLM 332 OHM 1% 1/8W
A 3 R 45	0698- 6229	R FXD MET FLM 870 OHM 1% 1/8W
A 3 R 46	0757- 0430	R FXD MET FLM 2210 OHM 1% 1/8W
A 3 R 47	0698- 7294	R FXD MET FLM 5550 OHM 1% 1/8W
A 3 R 48	0698- 7290	R FXD MET FLM 13.8 KOHM 1% 1/8W
A 3 R 49	0757- 0123	R FXD MET FLM 34.8K OHM 1% 1/8W
A 3 R 50	0698- 7291	R FXD MET FLM 89.6 KOHM 1% 1/8W
A 3 R 51	0698- 7293	R FXD MET FLM 251 KOHM 1% 1/4W
A 3 R 52	0757- 0121	R FXD MET FLM 258K OHM 1% 1/4W
A 3 R 53	0698- 4248	R FXD FLM 560 OHM 5% 1/4W
A 3 R 54	0757- 0273	R FXD MET FLM 3010 OHM 1% 1/8W
A 3 R 55	0757- 0436	R FXD MET FLM 4320 OHM 1% 1/8W
A 3 R 56	0698- 4258	R FXD FLM 1500 OHM 5% 1/4W
A 3 R 57	0698- 4265	R FXD FLM 3000 OHM 5% 1/4W
A 3 R 60	0757- 0407	R FXD MET FLM 200 OHM 1% 1/8W
A 3 R 61	0757- 0407	R FXD MET FLM 200 OHM 1% 1/8W
A 3 R 62	0757- 0421	R FXD MET FLM 825 OHM 1% 1/8W
A 3 R 63	0698- 4256	R FXD FLM 1200 OHM 5% 1/4W
A 3 R 64	0698- 4256	R FXD FLM 1200 OHM 5% 1/4W
A 3 R 65	2100- 2787	R VAR VERMET 220 OHM 20% 1/2W
A 3 R 66	0757- 0121	R FXD MET FLM 258K OHM 1% 1/4W
A 3 R 67	0757- 0429	R FXD MET FLM 1820 OHM 1% 1/8W
A 3 R 68	2100- 2741	R VAR VERMET 470 OHM 20% 1/2W
A 3 R 69	0698- 4264	R FXD FLM 2700 OHM 5% 1/4W
A 3 R 70	2100- 2791	R VAR VERMET 100 KOHM 20% 1/2W
A 3 R 71	0698- 4234	R FXD FLM 130 OHM 5% 1/4W
A 3 R 72	0757- 0424	R FXD MET FLM 1100 OHM 1% 1/8W
A 3 R 73	0757- 0435	R FXD MET FLM 3920 OHM 1% 1/8W
A 3 R 74	0698- 4263	R FXD FLM 2400 OHM 5% 1/4W
A 3 R 75	0698- 4235	R FXD FLM 150 OHM 5% 1/4W
A 3 R 76	0698- 4260	R FXD FLM 1800 OHM 5% 1/4W
A 4	08057-61901	STEP ATTENUATOR ASSY.-100B
A 4 C 1	0160- 2144	C FXD 3300 PF +80-20% 1KV
A 4 R 1	0698- 4190	R FXD MET FLM 50 OHM .25% 1/8W
A 4 R 2	0698- 5580	R FXD MET FLM 25K OHM .5% 1/8W

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
A 4 R 3	0698- 4190	R FXD MET FLM 50 OHM .25% 1/8W
A 4 R 4	0698- 6232	R FXD MET FLM 53.3 OHM .5% 1/8W
A 4 R 5	0698- 6230	R FXD MET FLM 790 OHM .5% 1/8W
A 4 R 6	0698- 6232	R FXD MET FLM 53.3 OHM .5% 1/8W
A 4 R 7	0698- 6233	R FXD MET FLM 61.11 OHM .5% 1/8W
A 4 R 8	0698- 6226	R FXD MET FLM 247.5 OHM .5% 1/8W
A 4 R 9	0698- 6233	R FXD MET FLM 61.11 OHM .5% 1/8W
A 4 R 10	0698- 6235	R FXD MET FLM 96.25 OHM .5% 1/8W
A 4 R 11	0698- 6227	R FXD MET FLM 71.16 OHM .5% 1/8W
A 4 R 12	0698- 6235	R FXD MET FLM 96.25 OHM .5% 1/8W
A 4 S 1	3100- 0518	SWITCH ROTARY 5 SECT 11 POS
A 5	08057-61902	STEP ATTENUATOR ASSY.-1DB
A 5 R 1	0757- 0284	R FXD MET FLM 150 OHM 1% 1/8W
A 5 R 2	0727- 0017	R FXD CARB FLM 37.35 OHM .5% 1/2W
A 5 R 3	0757- 0284	R FXD MET FLM 150 OHM 1% 1/8W
A 5 R 4	0698- 6236	R FXD MET FLM 292.4 OHM .5% 1/8W
A 5 R 5	0698- 6234	R FXD MET FLM 17.61 OHM .5% 1/8W
A 5 R 6	0698- 6236	R FXD MET FLM 292.4 OHM .5% 1/8W
A 5 R 7	0698- 6237	R FXD MET FLM 436.2 OHM .5% 1/8W
A 5 R 8	0698- 6231	R FXD MET FLM 11.61 OHM .5% 1/8W
A 5 R 9	0698- 6237	R FXD MET FLM 436.2 OHM .5% 1/8W
A 5 R 10	0698- 6229	R FXD MET FLM 870 OHM 1% 1/8W
A 5 R 11	0727- 0005	R FXD CARB FLM 5.77 OHM .5% 1/2W
A 5 R 12	0698- 6229	R FXD MET FLM 870 OHM 1% 1/8W
A 5 S 1	3100- 0517	SWITCH ROTARY 5 SECT 10 POS
A 6	08057-61903	STEP ATTENUATOR ASSY.-01DB
A 6 C 1	0160- 2144	C FXD 3300 PF +80-20% 1KV
A 6 R 1	0698- 7292	R FXD MET FLM 1450 OHM 0.5% 1/8W
A 6 R 2	0683- 0685	R FXD COMP 6.8 OHM 5% 1/4W
A 6 R 3	0727- 0446	R FXD CARB FLM 7 OHM 1% 1/2W
A 6 R 4	0698- 7292	R FXD MET FLM 1450 OHM 0.5% 1/8W
A 6 R 5	0698- 7289	R FXD MET FLM 2910 OHM 0.5% 1/8W
A 6 R 6	0811- 2108	R FXD WW 1.722 OHM 1% 3/8W
A 6 R 7	0698- 7289	R FXD MET FLM 2910 OHM 0.5% 1/8W
A 6 R 8	0698- 4442	R FXD MET FLM 4420 OHM 1% 1/8W
A 6 R 9	0811- 2738	R FXD WW 1.15 OHM 0.5% 1/10 W
A 6 R 10	0698- 4442	R FXD MET FLM 4420 OHM 1% 1/8W
A 6 R 11	0698- 6206	R FXD MET FLM 8760 OHM 1% 1/8W
A 6 R 12	0811- 2738	R FXD WW 1.15 OHM 0.5% 1/10W
A 6 R 13	0811- 2738	R FXD WW 1.15 OHM 0.5% 1/10W
A 6 R 14	0698- 6206	R FXD MET FLM 8760 OHM 1% 1/8W
A 6 S 1	3100- 0517	SWITCH ROTARY 5 SECT 10 POS
A 7	08057-265046	BOARD - P.C.
A 7 J 1	1251- 0324	CONNECTOR TEST POINT
A 7 R 1	0698- 4265	R FXD FLM 3000 OHM 5% 1/4W
A 7 R 2	0757- 1016	R FXD MET FLM 550 OHM .25% 1/2W
A 7 S 1	3101- 0518	SWITCH PUSH BUTTON
C 1	0160- 2218	C FXD 1000PF +5%

See introduction to this section for ordering informatin

Table 6-1. Reference Designation Index (Cont' d.)

Reference Designation	Part No.	Description #
C 2	0160- 2218	C FXD 1000 PF 5% 300V
DS 1	2140- 0008	PILOT LIGHT
F 1	2110- 0064	FUSE CARTRIDGE SLOW BLOW 150MA230V
J 1	1250- 0118	CONNECTOR BNC
J 2	1250- 0118	CONNECTOR BNC
J 3	1250- 0118	CONNECTOR BNC
J 4	1250- 0118	CONNECTOR BNC
J 5	1250- 0118	CONNECTOR BNC
J 6	1251- 2165	CONNECTOR,5 PIN
J 7	1251- 0148	CONNECTOR,POWER
R 1	0758- 0049	R FXD MET FLM 33 kΩ, 5%, 1/4 W
S 1	3101- 0011	SWITCH SLIDE-CLOCK
S 2	3101- 0011	SWITCH SLIDE-OUTPUT
S 3	3101- 0033	SWITCH SLIDE-POWER
T 1	5080- 0913	TRANSFORMER POWER
	-	MISCELANEOUS
	1400- 0084	FUSE HOLDER
	0370- 0121	KNOTS-PUSH BUTTON
	0370- 0330	KNOB-BAR

See introduction to this section for ordering information

SECTION VII

CIRCUIT DIAGRAMS

7–1 INTRODUCTION

7–2 This section contains the circuit diagrams and component location drawings necessary for the maintenance of the Model 8057A. Table 7–1 lists notes which apply to the schematic diagrams.

7–3 The logic schematics of the integrated micro circuits used in this instrument are shown in Figure 7–1.

Table 7–1. Schematic Diagram Notes

Refer to MIL–STD–15–1 for schematic symbols not listed in this table.

Unless otherwise indicated:
capacitance in microfarads
inductance in microhenries
resistance in ohms

= Front panel marking

= Rear panel marking

* = Optimum value selected at factory

P/O = Part of

= Primary signal path

= Feedback path

= Waveform test point (with number)

= Avalanche (zener) diode

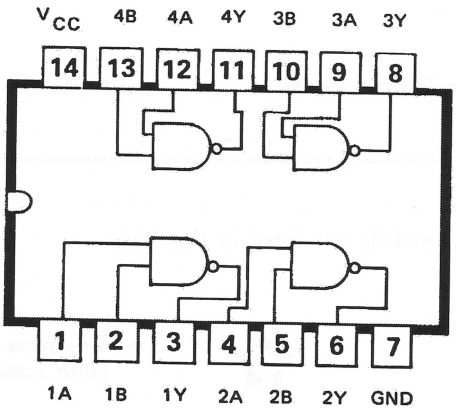
Numbers in parentheses indicate wire color using resistor color code, e.g. WHT–RED–GRN is (9·2·5)

0 – Black	5 – Green
1 – Brown	6 – Blue
2 – Red	7 – Violet
3 – Orange	8 – Gray
4 – Yellow	9 – White

MICROCIRCUIT PACKAGES

1820–0054

QUADRUPLE 2-INPUT POSITIVE NAND GATE

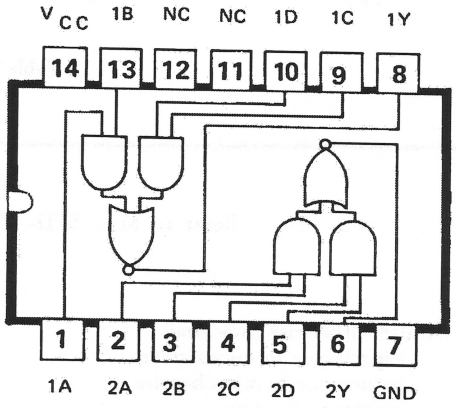


positive logic

$Y = \overline{AB}$

1820–0063

DUAL EXCLUSIVE OR GATE

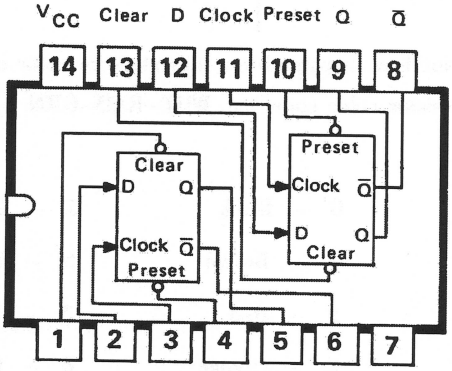


positive logic

$Y = \overline{(AB) + (CD)}$

1820–0077

DUAL D–TYPE EDGE–TRIGGERED FLIP–FLOP



positive logic

a. Low input to clear sets Q to logical 0.
b. Low input to preset sets Q to logical 1.
c. Clear or preset inputs dominate regardless of clock and D inputs.

TRUTH TABLE (Each Flip-Flop)

t_n	t_{n+1}	
INPUT D	OUTPUT Q	OUTPUT $\overline{Q}$
0	0	1
1	1	0

NOTES: 1. t_n = bit time before clock pulse

2. t_{n+1} = bit time after clock pulse

Figure 7–1. Microcircuit Packages

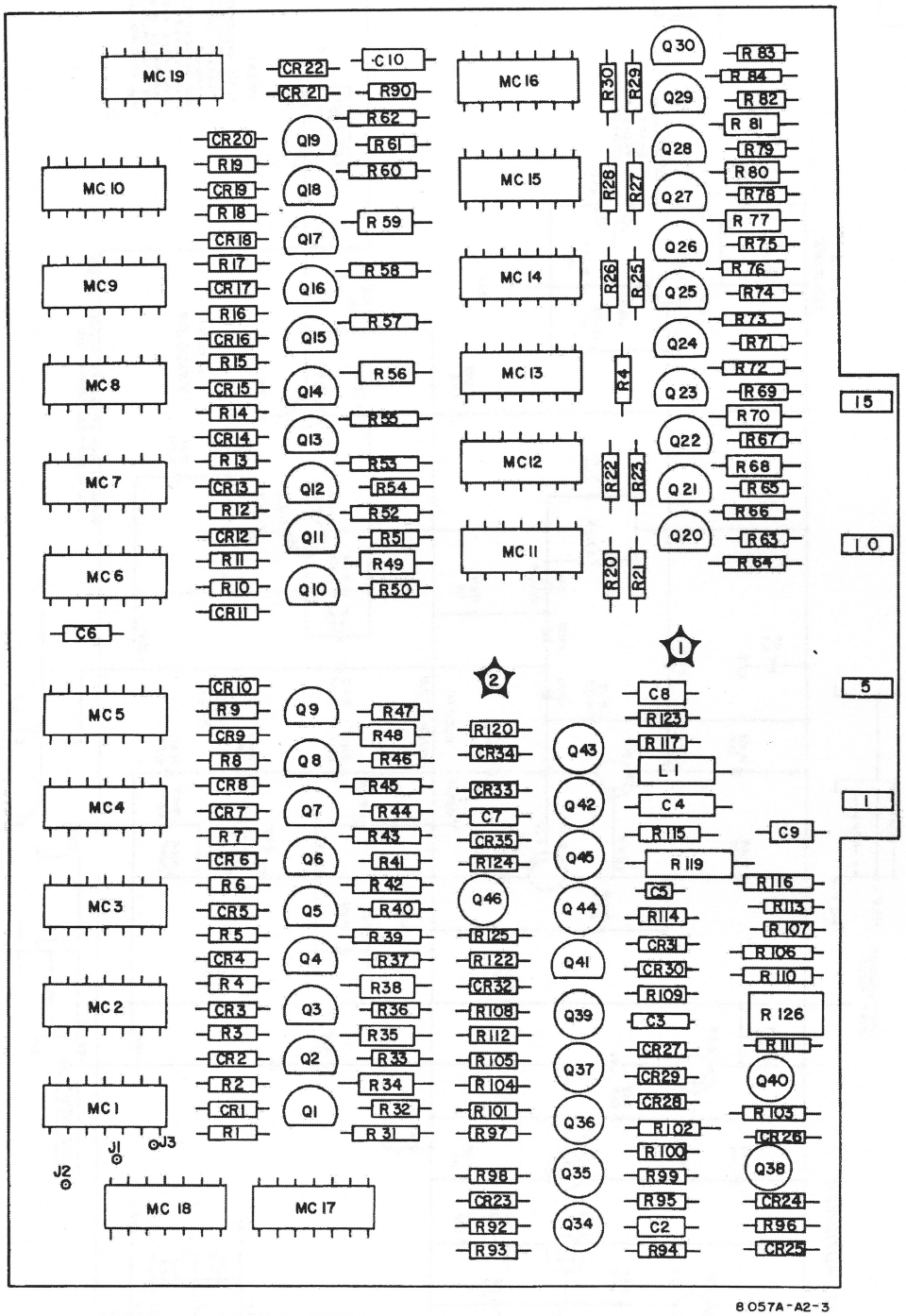


Figure 7–2. A2 Component Location

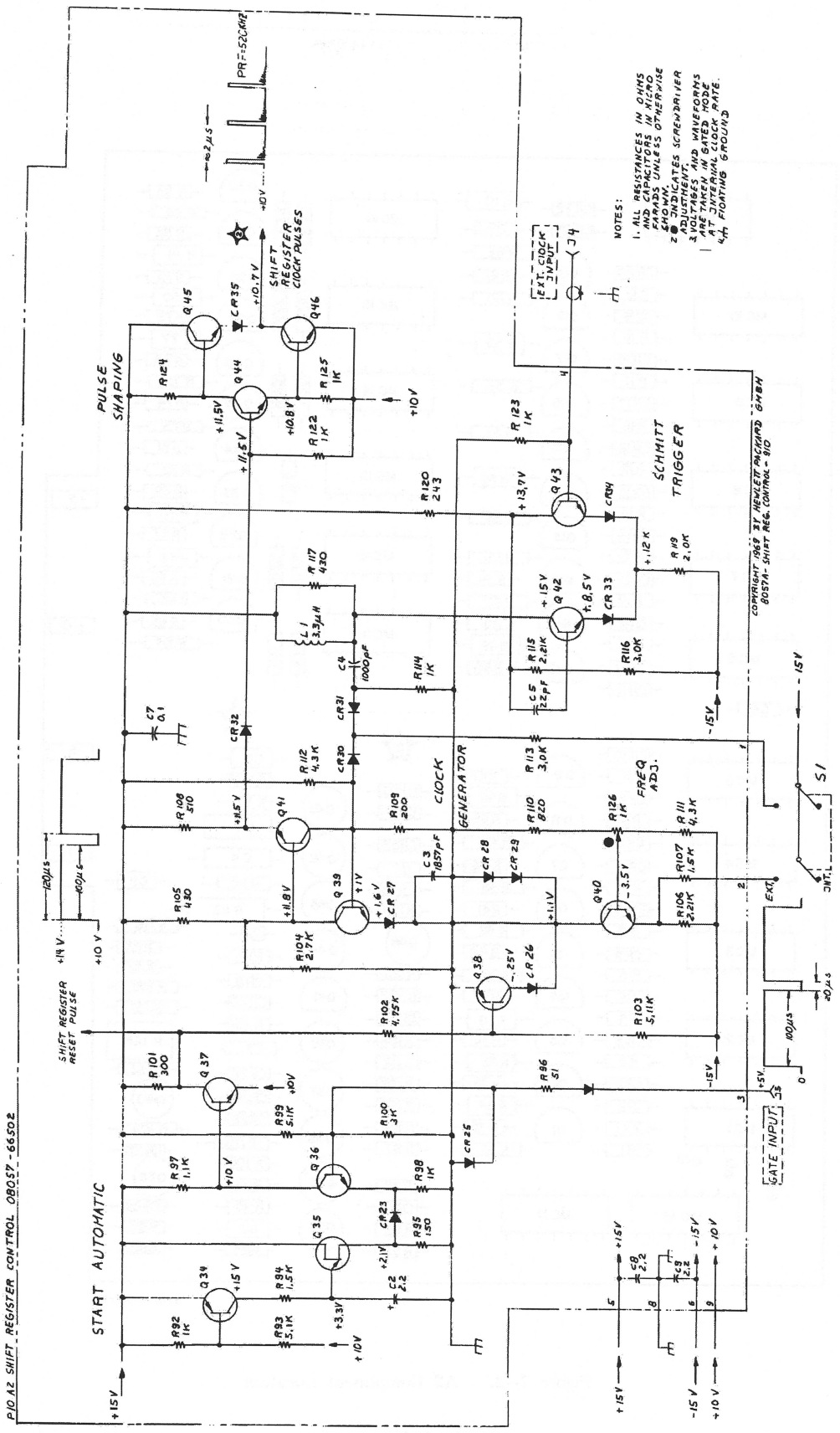


Figure 7–3 Shift Register Control

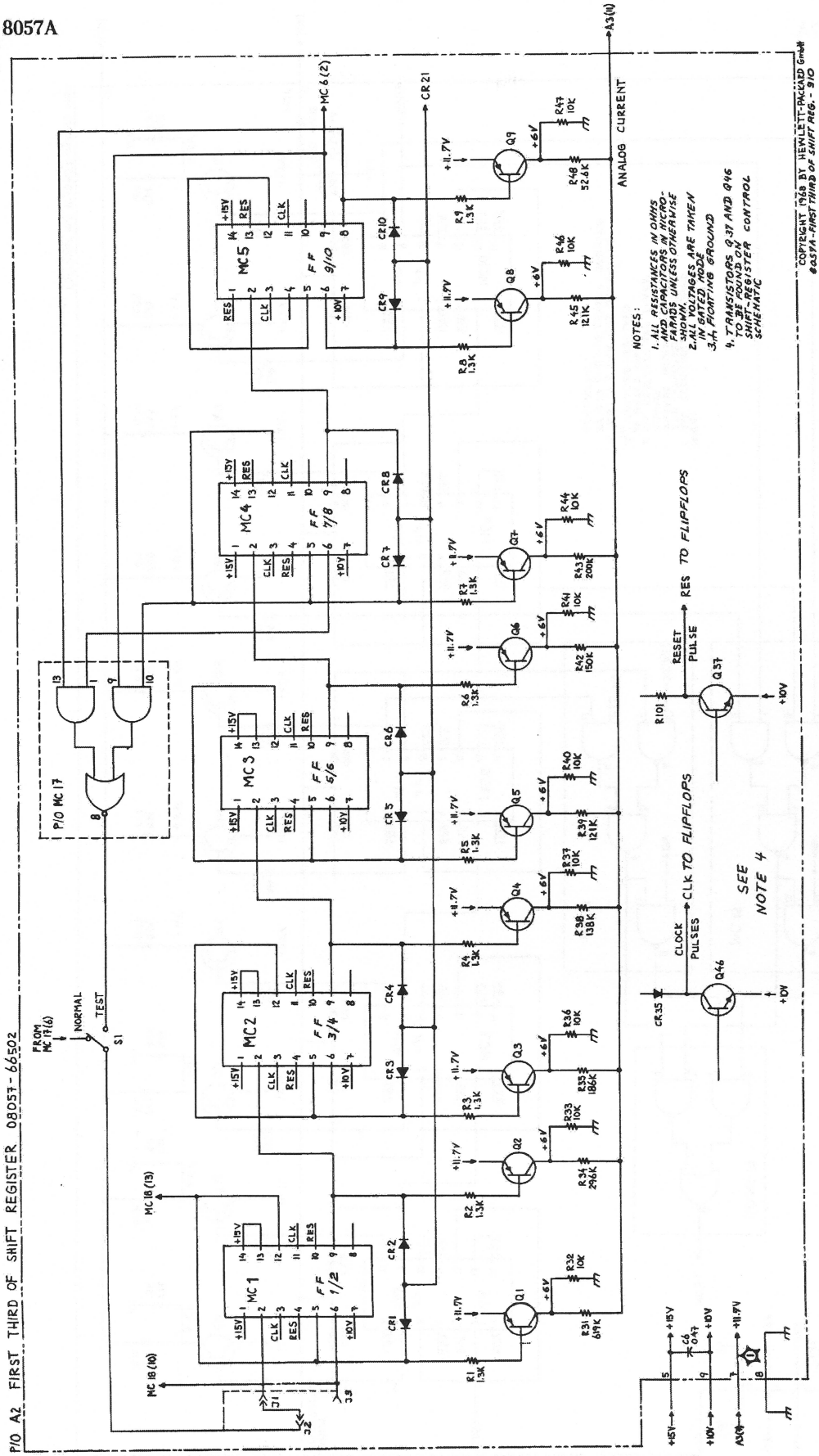


Figure 7–4 First Third of Shift Register

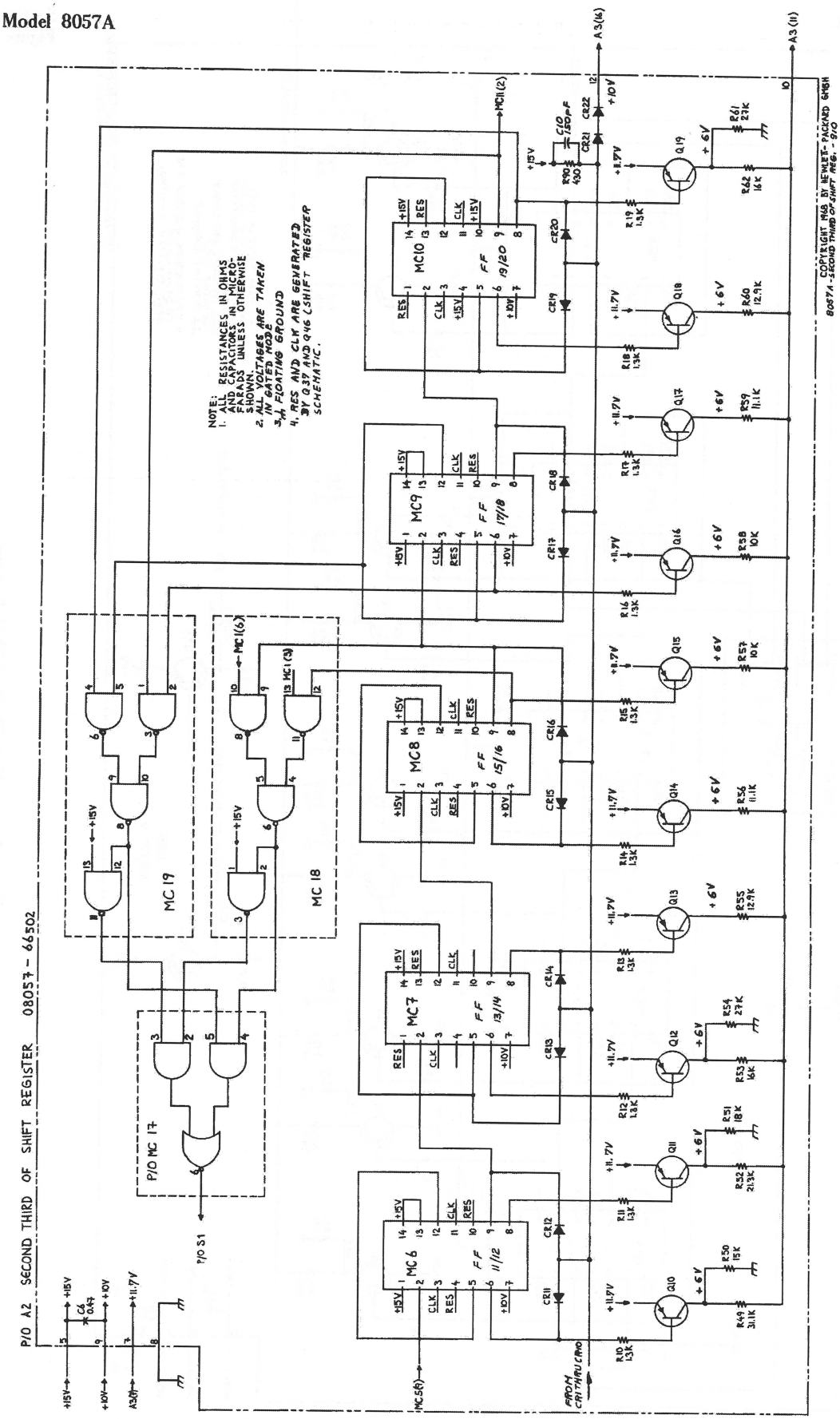


Figure 7–5 Second Third of Shift Register

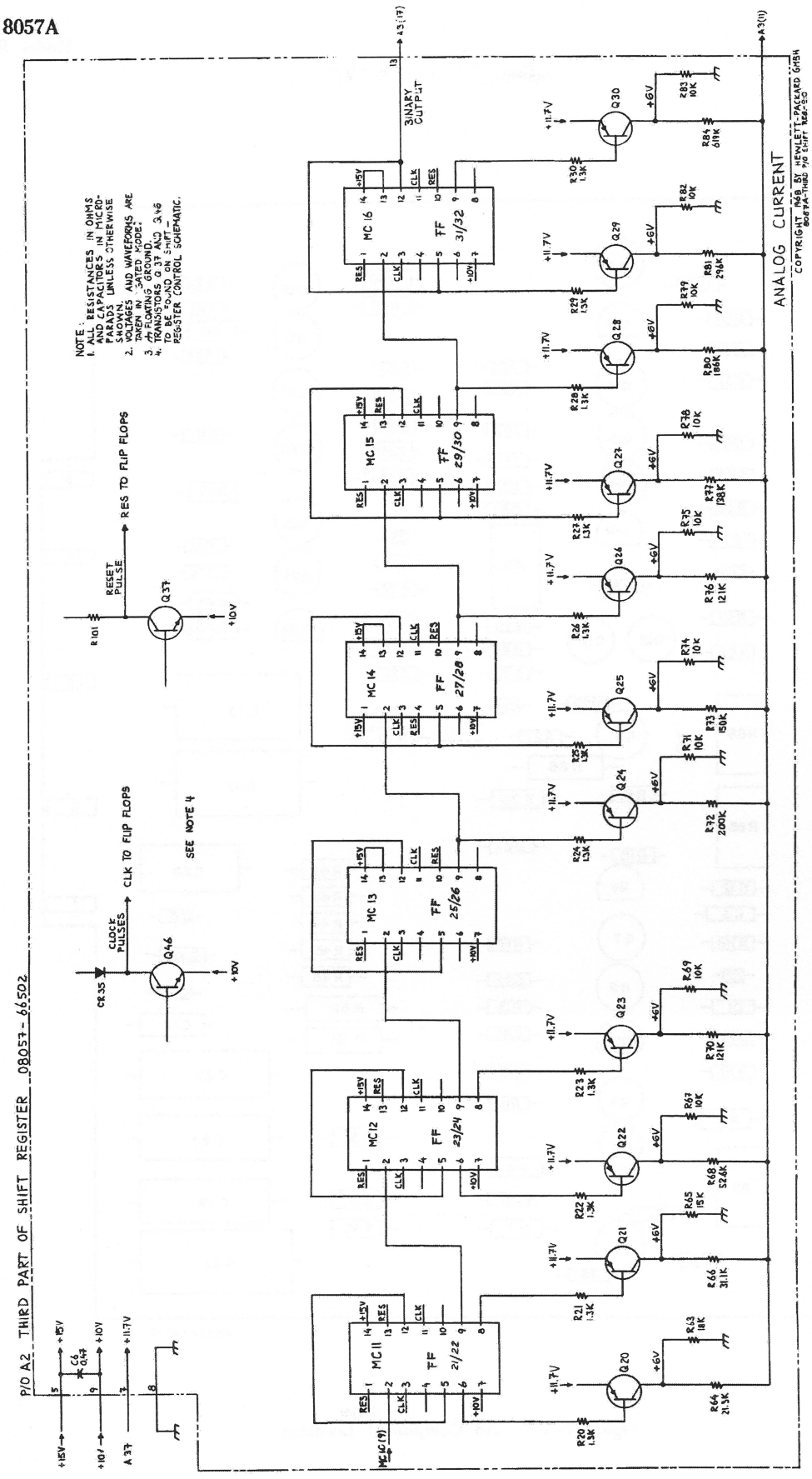


Figure 7–6 Third Part of Shift Register

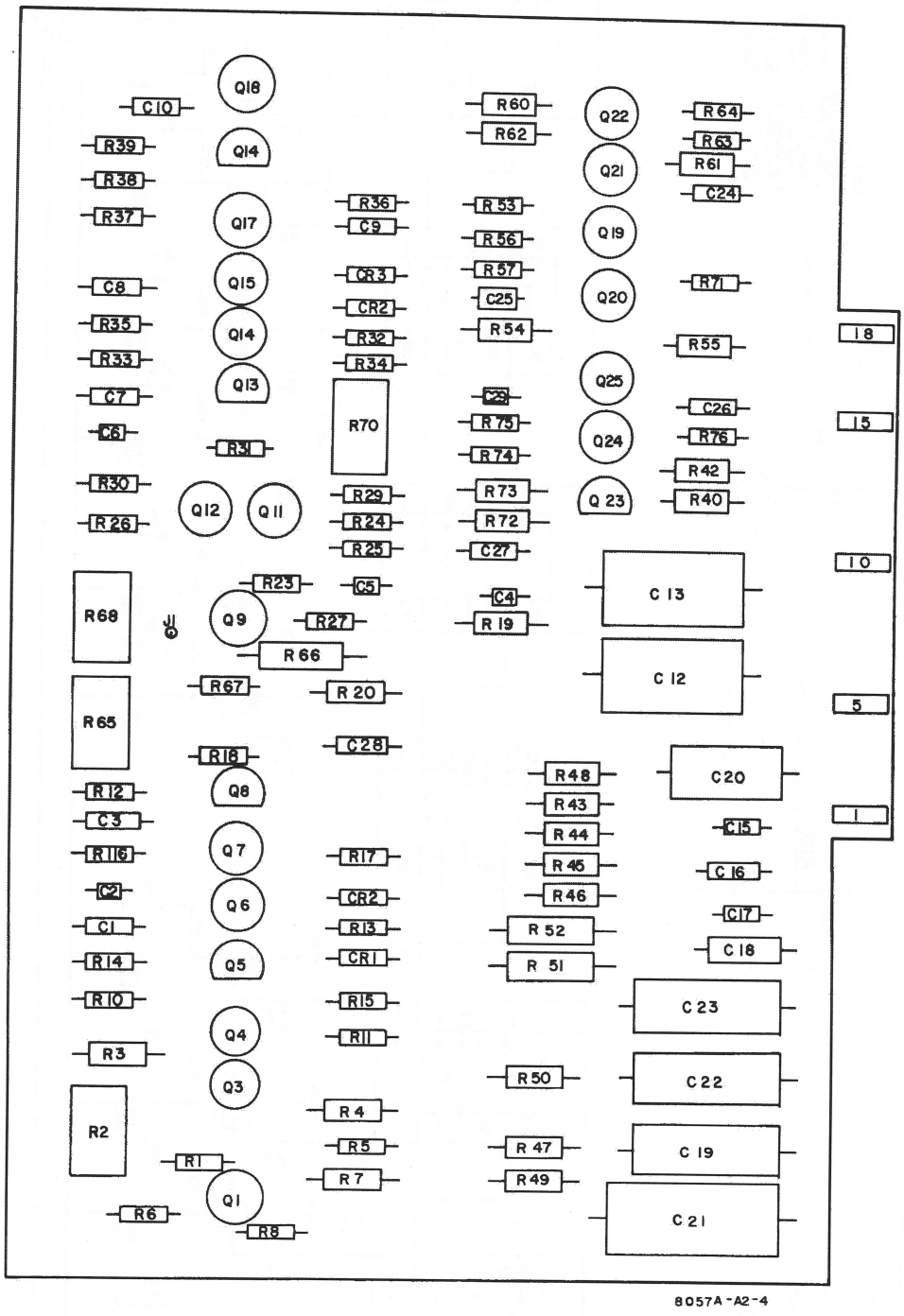


Figure 7–7. A3 Component Location

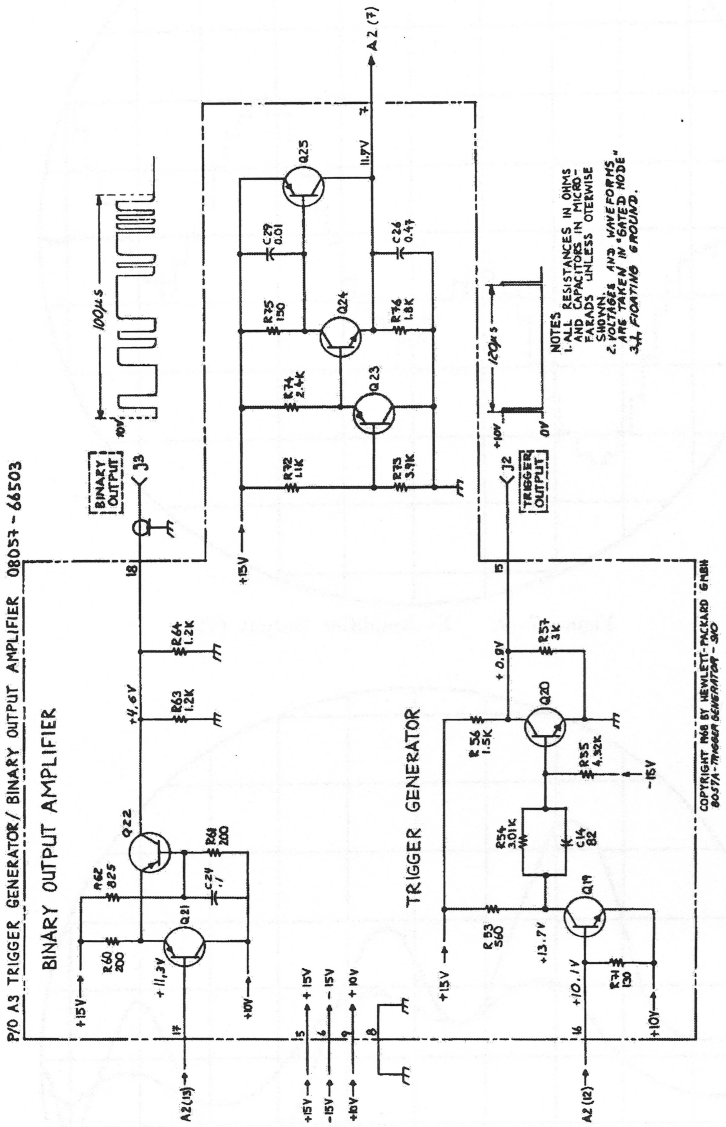


Figure 7–8 Trigger Generator/Binary Output Amplifier

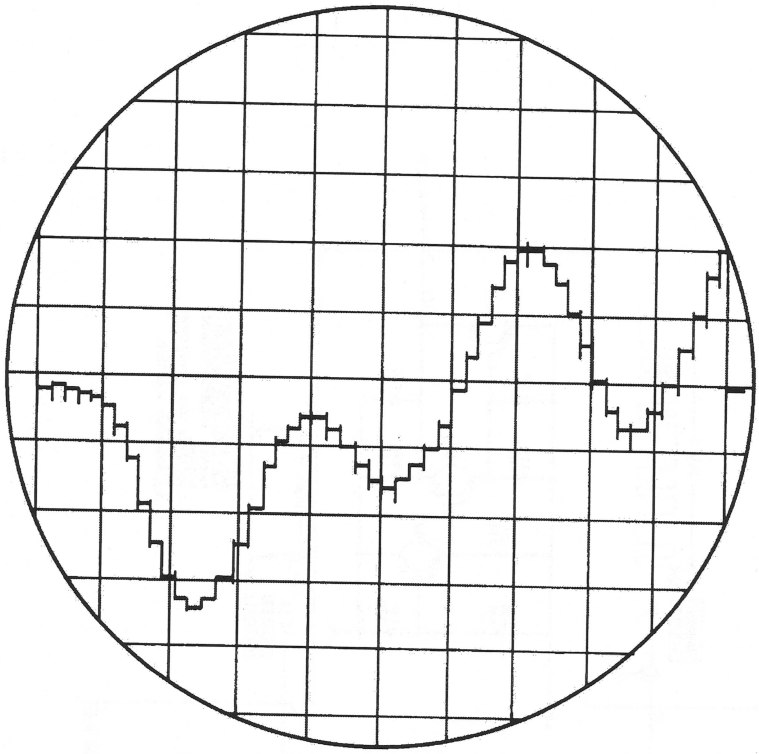


Figure 7–9. Σ– Amplifier Output (TP1)

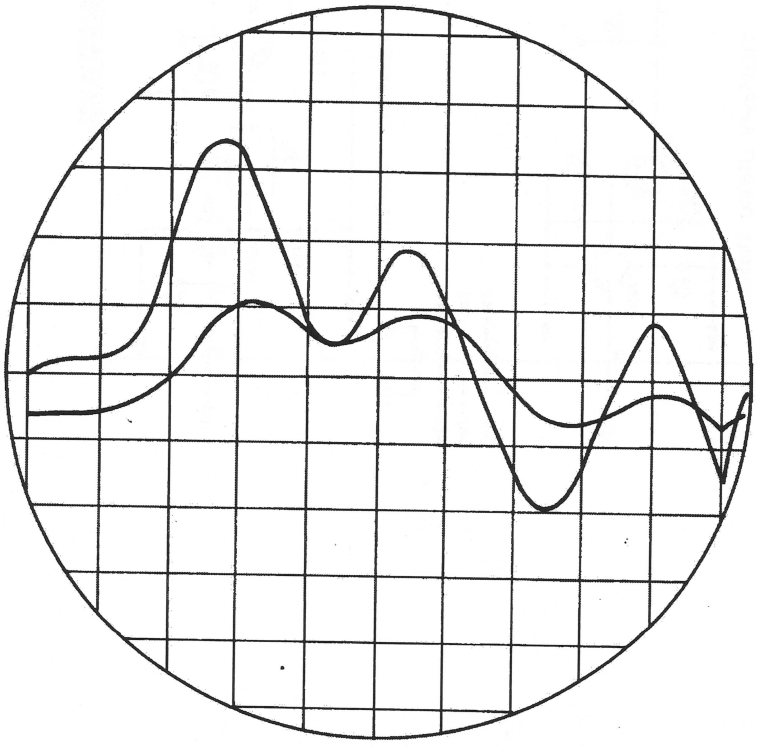


Figure 7–10. Smoothing Filter Output (pin 13)

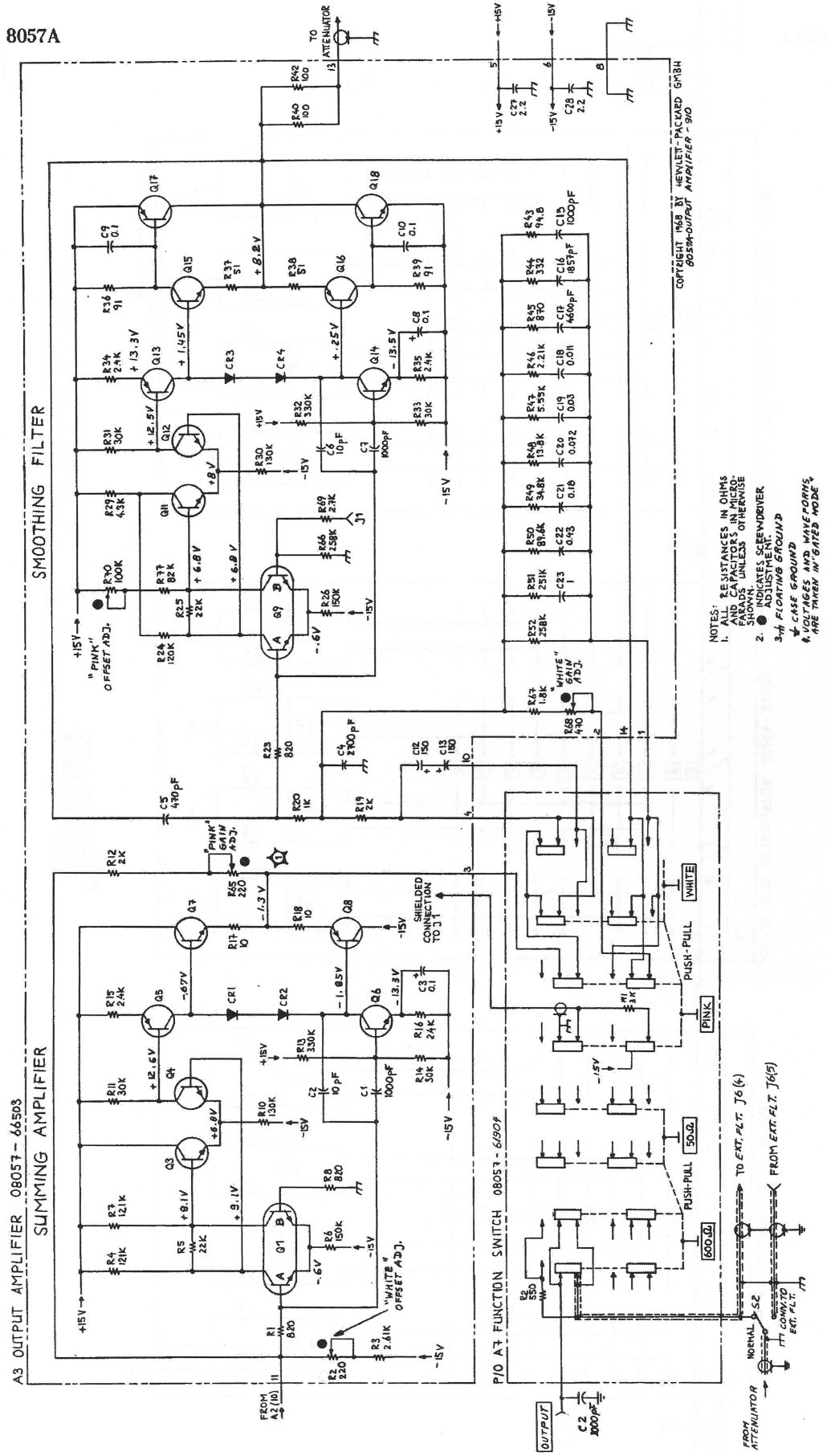


Figure 7–11 Output Amplifier

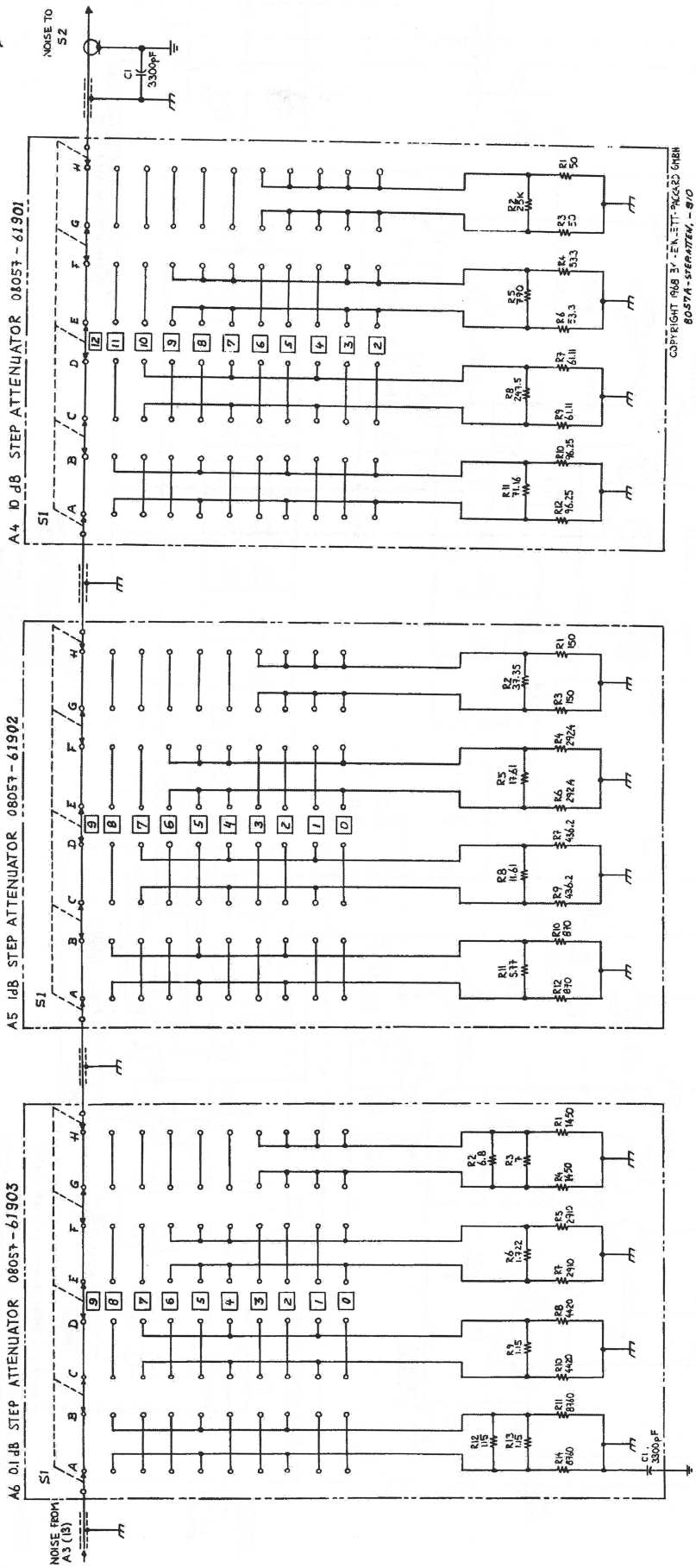


Figure 7–12 Step Attenuator

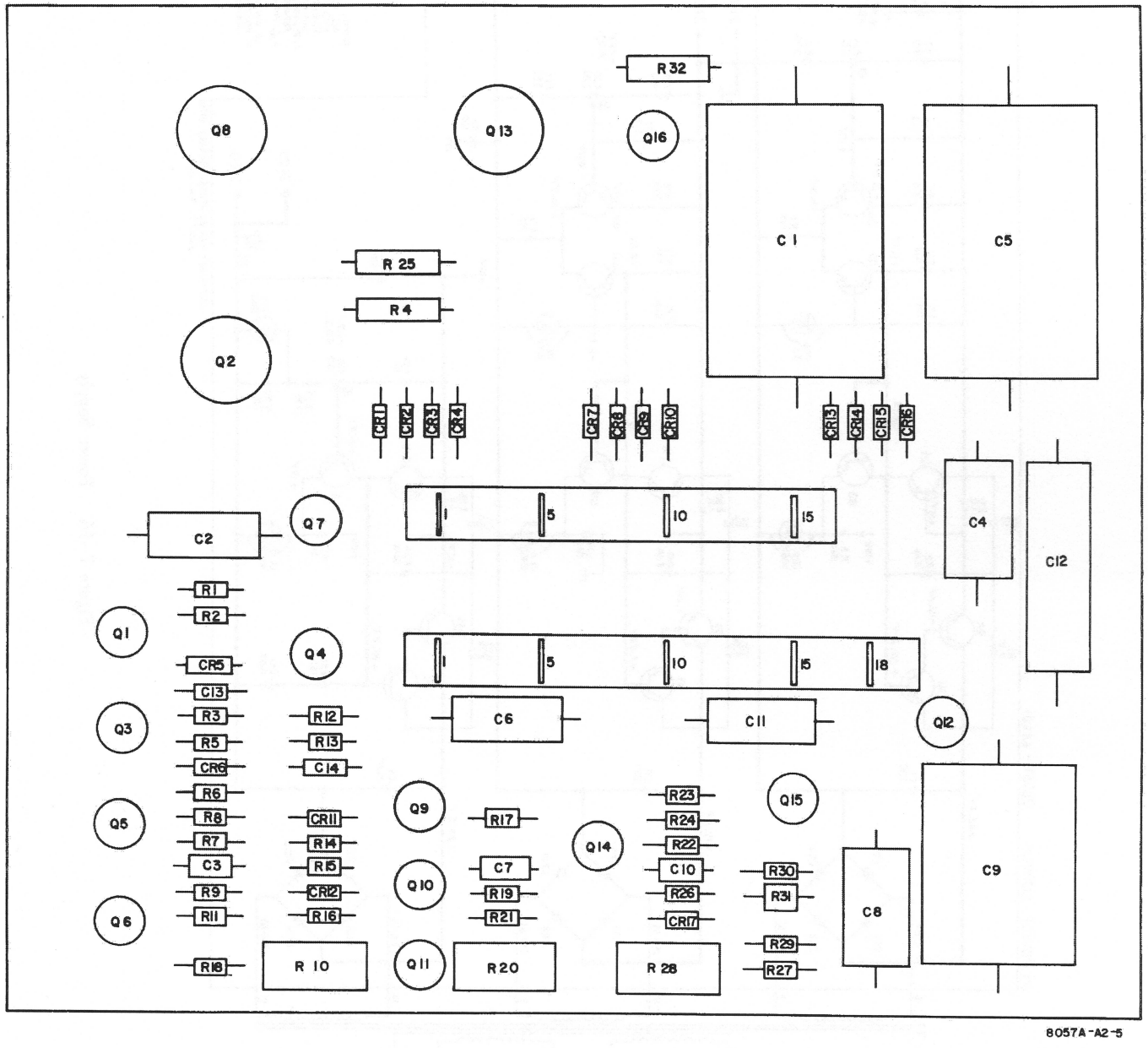


Figure 7–13. A1 Component Location

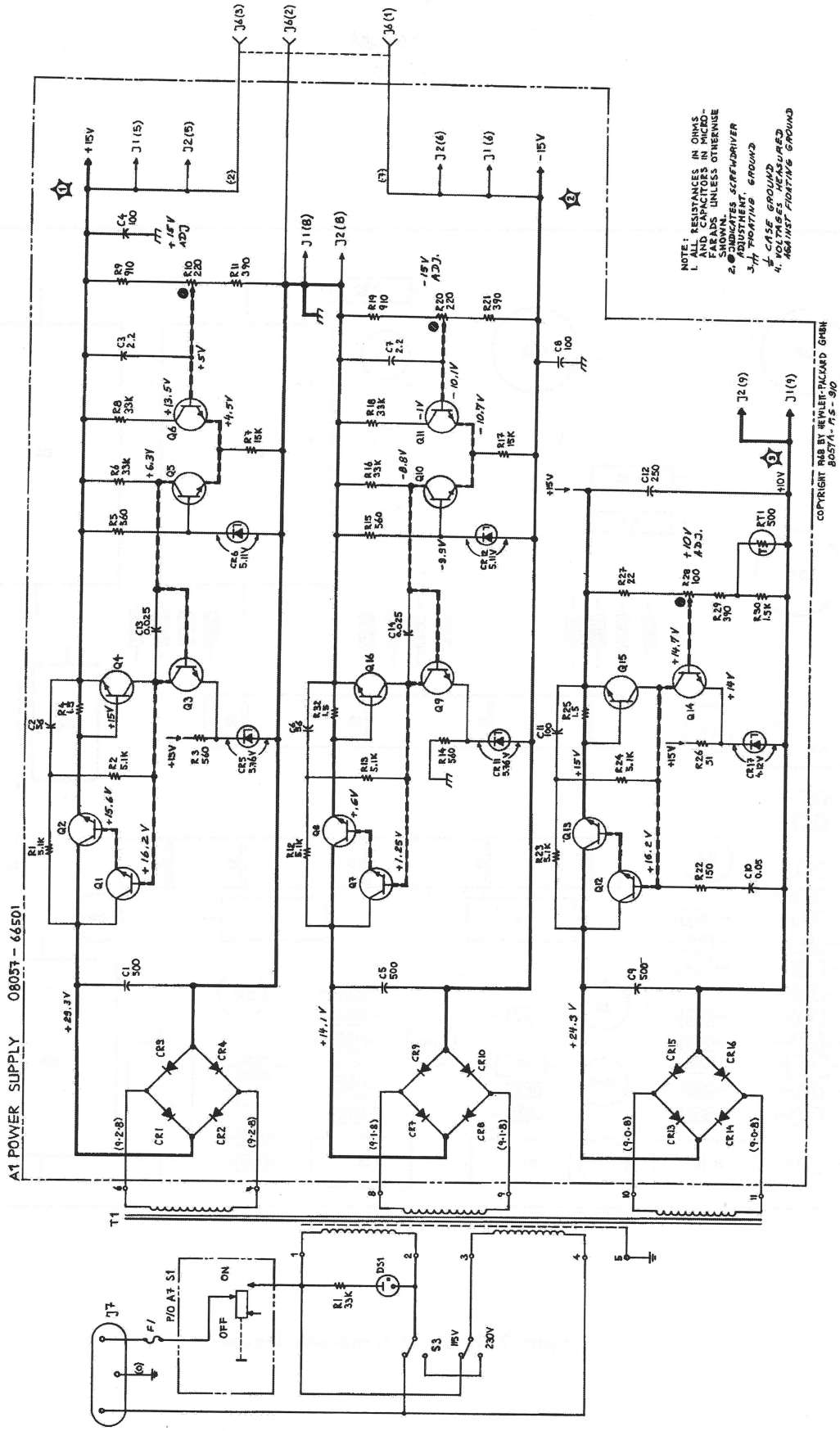


Figure 7–14 Power Supply

APPENDIX

HARMONIC ANALYSIS

A periodic signal is characterized by its fundamental frequency f_1, that is the lowest frequency component present. The fundamental frequency component is accompanied by others which always have a higher frequency than f_1 and usually have a smaller amplitude than that of the fundamental. These components are generally harmonics of the fundamental, so called because they have frequencies which are integral multiples of f_1 (that is $2f_1$, $3f_1$, $4f_1$, etc.).

Figure A–1 shows a simple non–sinusoidal waveform derived by addition of a fundamental and its second harmonic, the amplitude of the harmonic being half that of the fundamental.

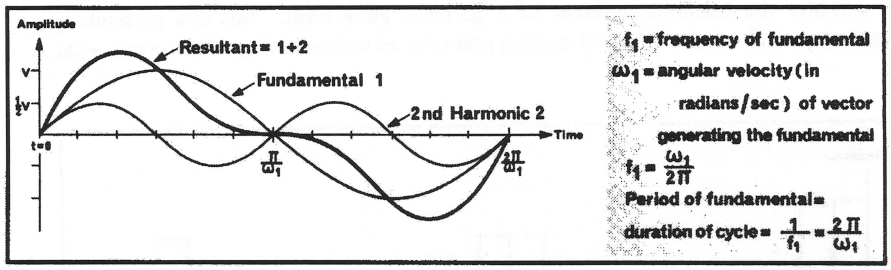


Figure A–1 Complex waveform comprising fundamental and second harmonic.

If we were to measure the amplitude of the harmonics (with, say, a wave analyzer) and to plot the results against frequency, we should obtain the graph shown in Figure A–2. But, since a wave analyzer does not tell us the relative timing (or phase relationship) of the harmonics, we cannot say that the amplitude plot of Figure A–2 is uniquely related to the complex waveform (i.e. the resultant) of Figure A–1. This is shown by Figure A–3, in which the second harmonic is displaced in time to yield a radically different waveform – but the amplitudes of the two components are exactly the same as before.

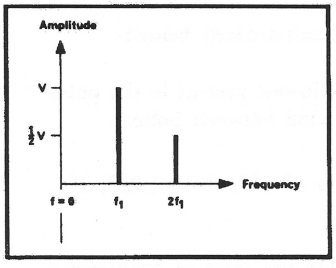


Figure A–2 Amplitude/frequency plot for waveforms in Figures A–1 and A–3.

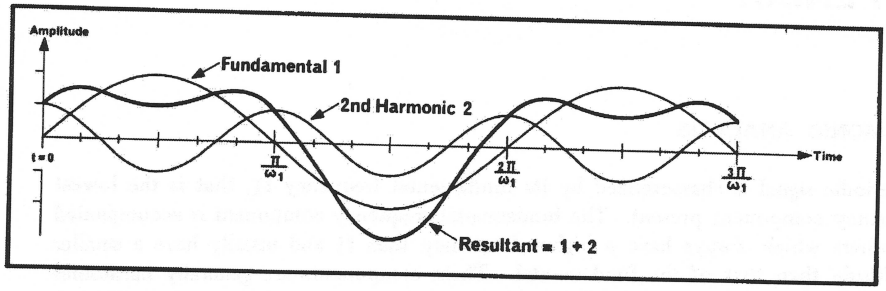


Figure A–3 Effect on complex waveform of 2nd harmonic phase shift.

PERIODIC PULSE TRAIN

Now consider the harmonic content of a periodic pulse train: this is a particularly interesting general case, and a good starting point for an understanding of noise concepts.

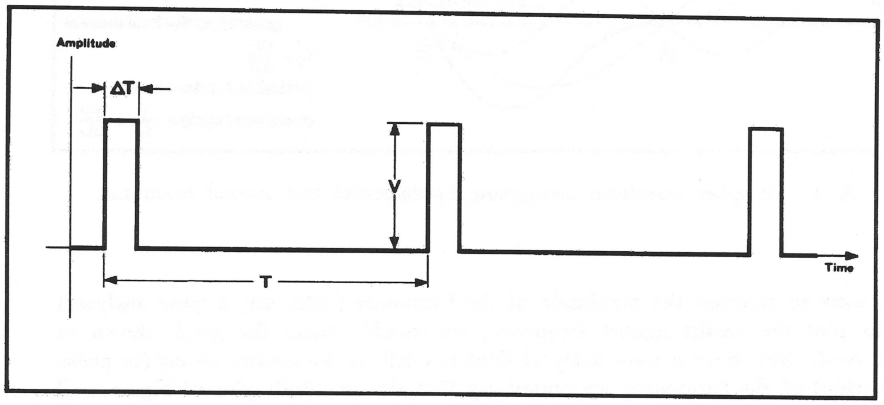


Figure A–4 Periodic rectangular pulse train.

The amplitude/frequency plot, or spectrum, of this rectangular pulse train is a familiar sight and is of the form shown below.

The important information contained in this spectrum is summarized below:

a. The fundamental frequency is – by definition – the lowest present in the pulse train and must, therefore, be 1/T (where T is the period between pulses).

b. The other components in the plot must be harmonics of 1/T, that is, 2/T, 3/T, 4/T, etc.

c. The envelope (dotted line) enclosing the components has nulls at frequencies which are multiples of 1/ΔT (i.e. reciprocal of pulse width).

d. The amplitudes of the harmonic components are proportional to the ratio of pulse width to pulse period (ΔT/T).

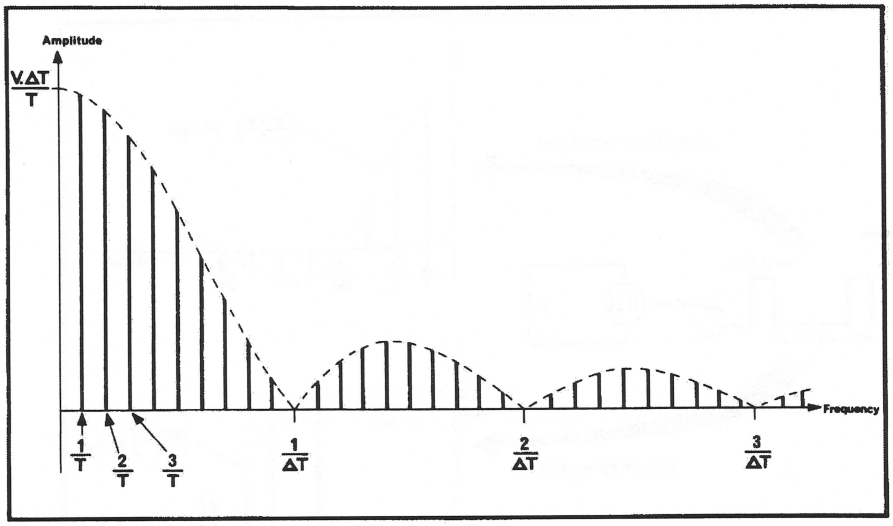


Figure A–5 Spectrum of periodic rectangular pulse train, as measured by wave analyser.

Figure A–5 shows the sort of spectrum obtained with a wave analyzer but, if we were to calculate the shape of the spectrum – using Fourier techniques – we should obtain the smooth curve, with negative lobes, shown in Figure A–6. This curve can be described by the general expression (sin x/x). The difference between the two spectra arises because the wave analyzer indicates only the magnitude of the harmonic components, not the sign: in all other respects, theoretical and practical spectra are identical.

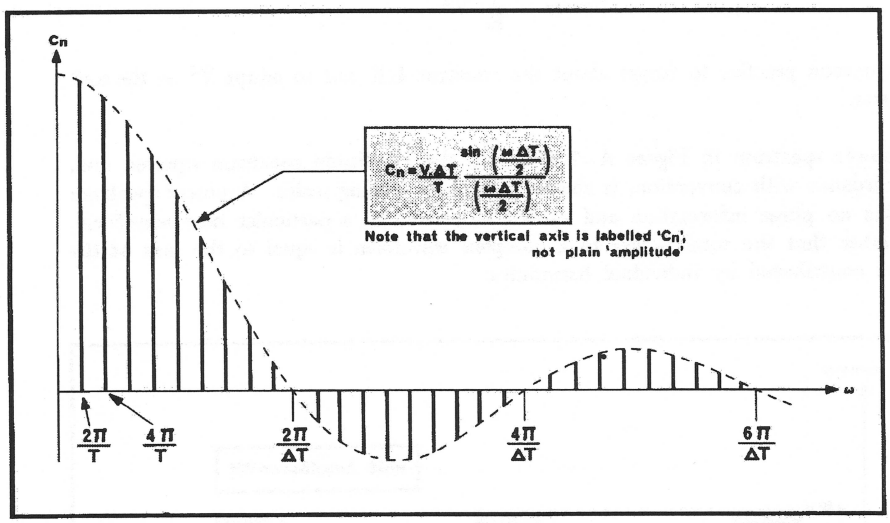


Figure A–6 Theoretical amplitude spectrum of periodic rectangular pulse train.

POWER SPECTRUM

The foregoing notes on the amplitude spectrum lead us naturally to one of the key concepts in noise theory – the power spectrum, which indicates the energy, or power contributed by each harmonic component.

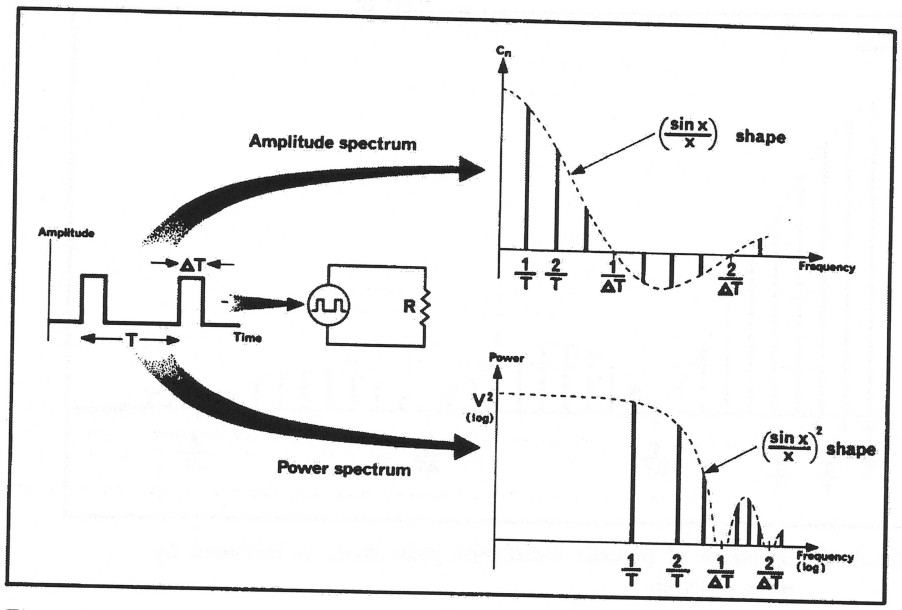


Figure A–7 Relationship of amplitude and power spectra.

No matter what system of units is used, power is always proportional to (amplitude)^2, in electrical work, amplitude is commonly measured in volts – in which case the constant of proportionality is 1/R, where R is the load resistance to which the voltage is applied.

$$\text{Power} = \frac{1}{R} \cdot V^2$$

It is common practice to forget about the constant 1/R and to adopt V^2 as the unit of power.

The power spectrum in Figure A–7 is simply the amplitude spectrum squared and, in accordance with convention, is shown plotted against log scales. A power spectrum contains no phase information and cannot be related to a particular time waveform. Remember that the total power in a complex waveform is equal to the sum of the powers contributed by individual harmonics.

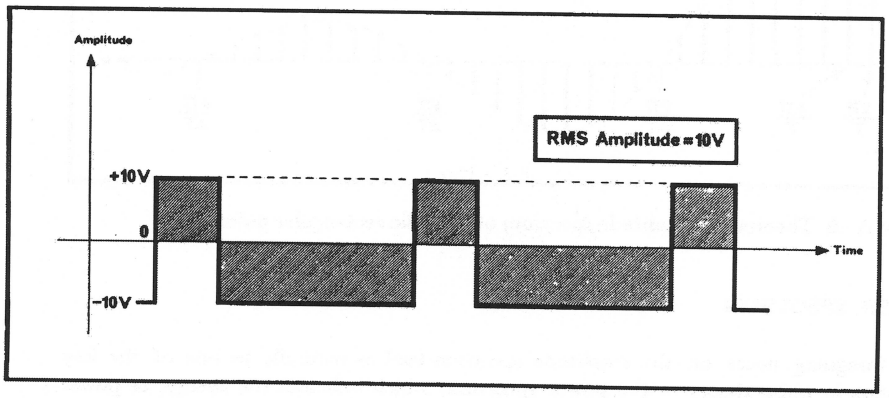


Figure A–8 RMS amplitude of rectangular wave.

For a rectangular wave symmetrical about the zero axis, the rms amplitude is equal to half the peak–to–peak amplitude: thus, for a rectangular wave of amplitude ± 10 V, the rms amplitude is 10 V/$\sqrt{2}$ (this has importance in connexion with the BINARY outputs from the 8057A.

P.R.B.S. SPECTRUM

Now consider a pseudo–random binary sequence (p.r.b.s.) in which the switching from one level to the other occurs on 'beats' of a clock period ΔT.

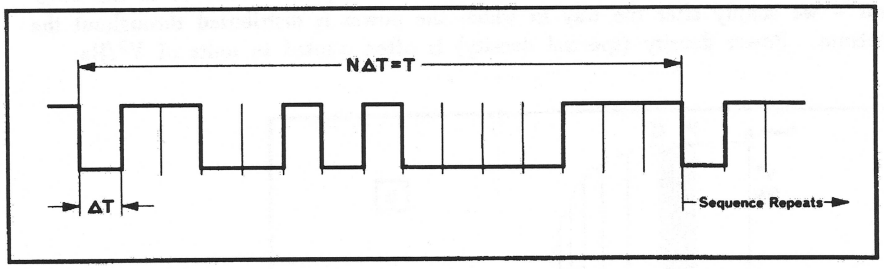


Figure A–9 Pseudo-random binary sequence (p.r.b.s.)

The power spectrum of this periodic binary pattern is similar to that of the rectangular pulse train.

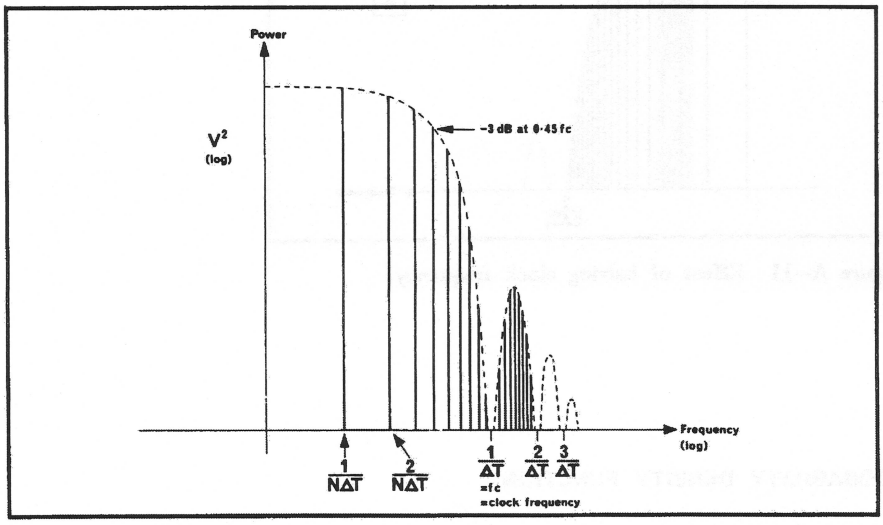


Figure A–10 Power spectrum of p.r.b.s.

Here the nulls in the spectrum occur at multiples of the clock frequency, $1/\Delta T$, and the harmonic components are at multiples of the lowest frequency present, $1/T = 1/N\ \Delta T$, exactly as in the pulse train spectrum;

EFFECT OF VARYING CLOCK FREQUENCY

We may alter ΔT, while maintaining the same number of components in the lobes. In (b) of Figure A–11 the clock frequency has been halved, doubling ΔT and thus causing the harmonic components to 'crowd in'. If the clock frequency is halved, the spacing of the components must also be halved, so the number of lines per lobe remains the same. But the number of lines in a given bandwidth (e.g. in the band PQ) is doubled. So the power per unit bandwidth (power density) in (b) is twice that in (a). Thus, by varying the clock frequency, we can control the power density, that is, the amount of power (or number of lines) in a given bandwidth. Remember that in varying the clock frequency we do not alter the total power contained in the waveform – we simply alter the way in which the power is distributed throughout the spectrum. Power density (spectral density) is often quoted in units of V^2/Hz.

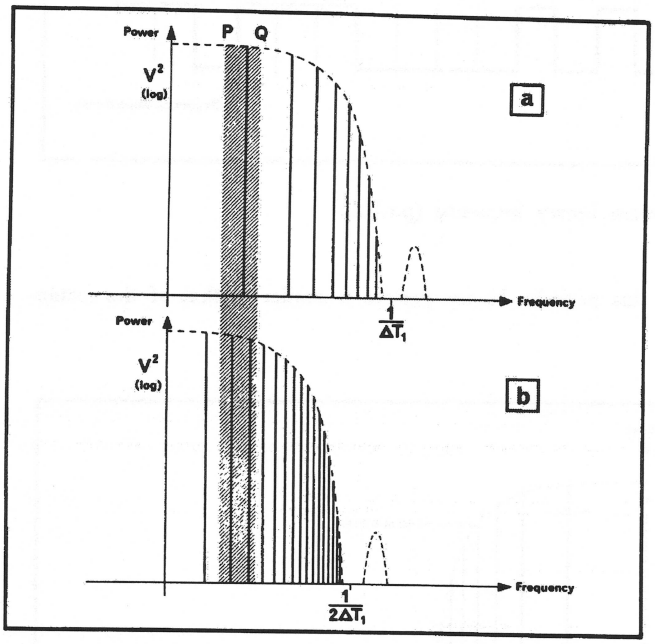


Figure A–11 Effect of halving clock frequency.

PROBABILITY DENSITY FUNCTION

Up to this point we have considered only the two–level (or binary) signal. The random binary signal is 'noise' in the sense that it contains all frequencies, but superficially it bears no resemblance to naturally occurring multi-level disturbances such as shot noise, thermal noise and atmospheric change. Although random two-level and random multi-level signals are completely different in the time domain, they can have identical power density spectra (i.e. identical frequency content). It follows that the power density spectrum is not a full description of a noise signal – we must have, in addition, a means of estimating, or predicting, the amplitude characteristics of the time waveform. To do this, we determine the proportion of time spent by the signal between one amplitude and another over a finite period of time.

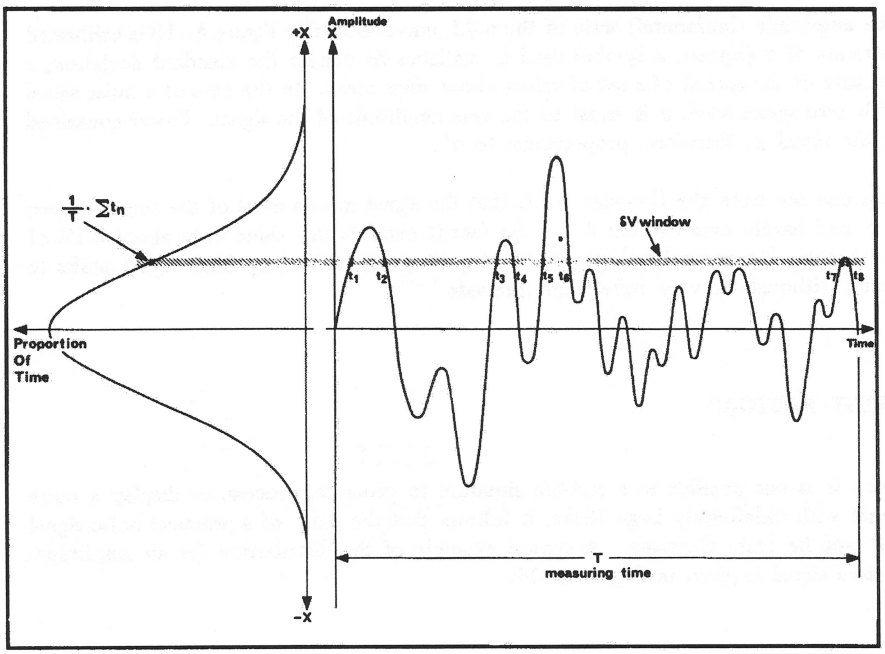


Figure A–12 Probability density function of multi-level noise signal.

Each point of the bell–shaped curve shown alongside the 'Gaussian type' noise waveform represents the proportion of the total measuring time (T) spent in a selection of windows δ V wide.

The curve obtained by this procedure is known as the probability density function (p.d.f.) of the waveform. The most commonly encountered p.d.f. – for naturally occurring signals – is a curve which tends to have a particular mathematical form known as the Gaussian, or normal, distribution.

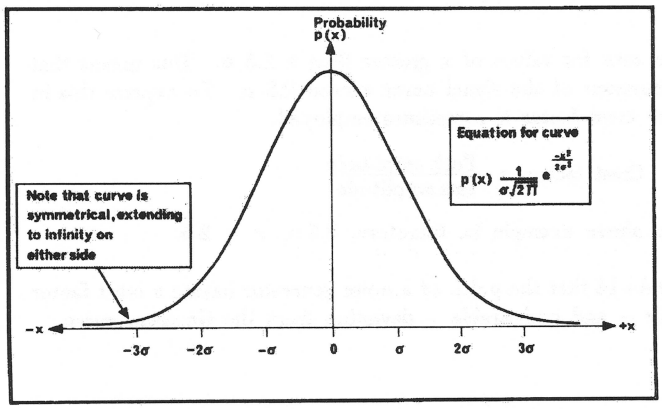


Figure A–13 Gaussian probability density function.

The amplitude (horizontal) scale of the p.d.f. curve shown in Figure A–13 is calibrated in terms of σ (sigma), a symbol used in statistics to denote the standard deviation, a measure of the spread of a set of values about their mean. In the case of a noise signal with zero mean level, σ is equal to the rms amplitude of the signal. Power contained in the signal is, therefore, proportional to σ^2.

You can see from the Gaussian p.d.f. that the signal spends most of the time between $\pm \sigma$, and hardly ever exceeds $\pm 3 \sigma$ (in fact it exceeds this value only about 0.1% of the time). Theoretically, however, it is quite possible for very large signal peaks to occur, although at very infrequent intervals.

CREST FACTORS

Since it is not possible in a real-life situation to generate, process, or display a noise signal with indefinitely large peaks, it follows that the p.d.f. of a practical noise signal will not be truly Gaussian. A typical example of the distribution for an amplitude-limited signal is given in Figure A–14.

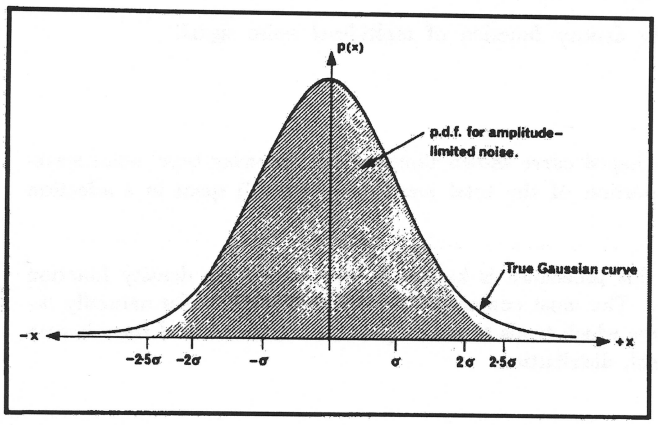


Figure A–14 Probability density function of amplitude-limited noise.

In this example, p(x) is zero for values of x greater than $\pm 2.5 \sigma$. This means that positive and negative excursions of the signal never exceed 2.5σ. To express this in shorthand form, the term crest factor is sometimes employed.

$$\text{Crest factor} = \frac{\text{Peak amplitude}}{\text{rms amplitude}}$$

The crest factor for the above example is, therefore, 2.5σ, $\sigma = 2.5$.

You can see from Figure A–14 that the p.d.f. of a noise generator having a crest factor of 2.5 shows considerable – and undesirable – deviation from the Gaussian curve.

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HEWLETT hp PACKARD GmbH

MANUAL CHANGES

M O D E L 8 0 5 7 A

PRECISION NOISE GENERATOR

Manual Prefixed: G910

Manual Printed: March 1969

To adapt this manual to your instrument, change the manual according to the following table.

Instrument Serial Numbers	Make Change Numbers
G910-00101 thru G910-00140	1 only
G910-00141 thru G910-00180	1 and 2
G910-00181 thru G910-00210	1 thru 3
G910-00211 thru G910-00225	1 thru 4
G910-00226 thru G910-00240	1 thru 5
G963-00241 thru 0963G00340	1 thru 6
0963G00341 and higher	1 thru 7

CHANGE 1

1.1 On Table 1-1 Gate Input, add:
"+4.5V to +12V enables noise output."

1.2 On Figure 3-2 step 9, add:
"Any external signal level between +4.5V and +12V enables noise output."

1.3 On page 3-1, add the following note.
"When using the HP Model 8055A filter set as external filter, set the attenuator switches between 90dB and 100dB."

1.4 On page 3-1 Turn-On Procedure step 1, add:
"Select proper fuse according to line voltage."

1.5 On page 6-11, delete the F1 entry and add the following entries.

F1 (for 115V operation)	2110-0201	Fuse 250V .25A Slow Blow
F1 (for 230V operation)	2110-0318	Fuse 250V .125A Slow Blow
W1	1251-0148	Cable Power

1.6 On page 4-2 paragraph 4-24, change the first sentence to read:
"Initially transistors Q39 and Q41 are non-conducting."

1.7 On page 4-3 paragraph 4-28, change "+10V" to "+12V".

1.8 On page 6-10, the A7 entry should read:
"A7 08057-61904 Assy Push-Button Switch"

1.9 In Table 6-1, change part numbers and descriptions as follows.

A2 R90	0757-0915	R FXD 430 OHM 5% 1/4W
A2 R105	0757-0915	" " " " " "
A2 R117	0757-0915	" " " " " "

1.10 On Figure 7-3, delete ground connection between CR27 and collector of Q40. Add reference designator CR24 to the diode between R96 and J5.

1.11 On figure 7-7, change the reference designator of the transistor between Q17 and Q18 to Q16.

1.12 On figure 7-11, change the circuit diagram as shown in the following diagram.

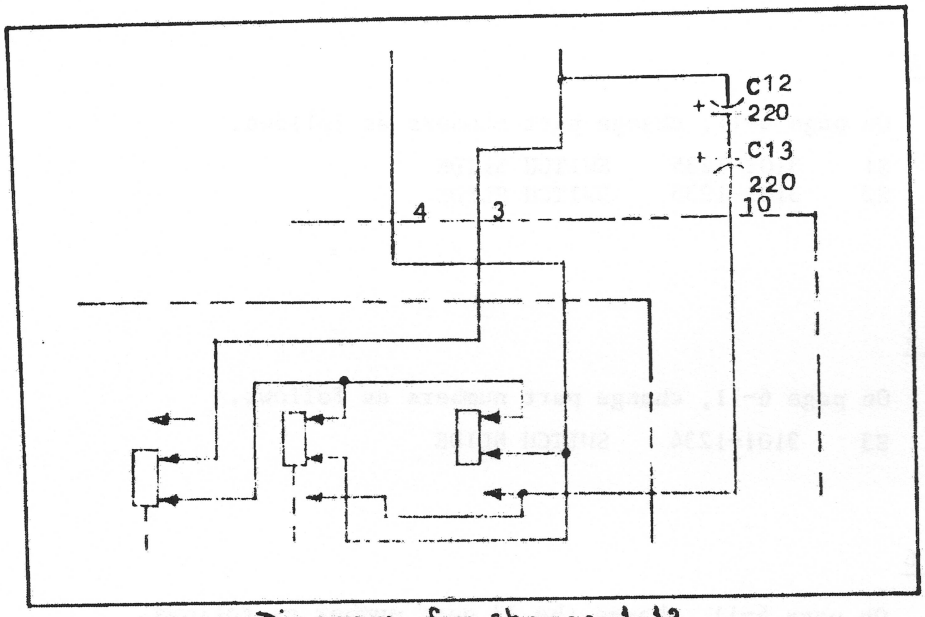

Diagram for change 1.12

CHANGE 2

2.1 On page 6-3, change the A2 C2 entry to read:
"A2C2 0180-1746 C FXD 15 UF 10% 20VDCW"

CHANGE 3

3.1 On page 6-7, change the A2 R113 entry to read:
"A2 R113 0698-4264 R FXD 2700 OHM 5%"

CHANGE 4

4.1 On page 6-11, change part numbers as follows.

S1	3101-1235	SWITCH SLIDE
S2	3101-1235	SWITCH SLIDE

CHANGE 5

5.1 On page 6-11, change part numbers as follows.

S3	3101-1234	SWITCH SLIDE

CHANGE 6

6.1 On page 6-11, change the J7 part number as follows.

J7	1251-2357	CONNECTOR POWER

6.2 On page 6-11, add:

W1	8120-1349	CABLE POWER

CHANGE 7

7.1 On page 6-8 change part number as follows:

A3 C23 0160-0542

7.2 On page 6-11 add the following part:

1200-0432 SOCKET CONTACT